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ABSTRACT

This collection of articles describes the evaluation activities of the inservice education and training (INSET) programs of the Shell Mathematics and Science Centre. The activities occurred during the first half of 1990 and concentrated specifically on physical science, biology, and mathematics. Twenty articles are presented in the following six sections: (1) Introductory Articles: "Continuous Utilisation of Evaluation Feedback" (P. Botha), and "Statement of Intent of the Centre and Its Implications for Action" (S. Hardman); (2) Physical Science: "Introduction" (P. Hobden), "Rationale" (P. Hobden), "Descriptive Report" (P. Hobden), "An Observation Study of the Workshops" (E. Russell), "Evaluation of a Short INSET Programme" (P. Hobden and A. Lewy), and "Laboratory Development Project" (T. O'Neill and P. Hobden); (3) Biology: "Biology INSET Programme" (A. Ziervogel), "Rationale" (A. Ziervogel), "An Overview of the First Day of the Shell Centre Biology Workshop" (E. Russell), and "Evaluation Comments" (A. Ziervogel); (4) Mathematics: "Mathematics INSET Programme" (P. Ntenza), "Rationale" (P. Ntenza), "Description of a Workshop" (P. Ntenza), "Summary of INSET Activities" (P. Ntenza), and "Interviews with Teachers Attending Mathematics Workshops" (E. Russell); (5) Field Units: "The Shell Science and Mathematics Resource Centre Network" (S. Hardman) and "Using Evaluation Data for Planning Actions" (S. Hardman); and (6) "Concluding Remarks" (A. Lewy). (MDH)

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THE SHELL SCIENCE CENTRE

IN INSET 1990

Compiled by
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Individual articles in this collection
have been edited by A. Lewy

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Preface

The following collection of articles developed out of an evaluation programme commissioned by Dr PMC Botha and overseen by Professor A. Lewy of the University of Tel Aviv. Data collection occurred during the first half of 1990.

Although the full evaluation programme, as described by Dr Botha in the first article, *Continuous Utilization of Evaluation Feedback: The use made of evaluation in the Centre*, did not take place as a result of particular circumstances both within the Centre and the communities served by it, a number of articles were written based on data collected for the evaluation. These articles are published in this collection to share with the broader INSET community the scope and approach adopted in the work of the Centre.

During the latter half of 1990 and 1991 the focus of the Centre was narrowed to concentrate specifically on physical science, biology and mathematics, both in the context of non-formal INSET and subject based professional teacher organisations. Greater concentration has also been placed on the important role played by the school principal on supporting teacher innovation. Despite the change in focus the underlying philosophy and INSET model of the Centre, as reflected in the articles in this collection, remains the same. It is for this reason that these articles are published.

S. HARDMAN

November 1991

Continuous Utilisation of Evaluation Feedback:

Reflections on the use made of evaluation in the Shell Science Centre

P M C Botha

Introduction

The operation of the Shell Science Centre is characterised by a continual effort to improve its programmes. Accordingly, it takes advantage of both informal and formal feedback provided to those who are in charge of making decisions about the programmes.

The sources of informal feedback are the experiences, view, opinions, and impressions of various groups of programme stakeholders. Programme planners pay attention to spontaneously expressed views, but they also try to elicit comments and recommendations, which are then critically examined. The sources of formal feedback are small-scale evaluation studies touching on critical aspects of the Centre's activities.

As specified in a previous report (Botha 1987:4)

> *(The Centre) operates as a Research and Development Institution. The team members of the Centre develop instructional materials, examine the quality of the materials and continuously improve them, and also improve other components of the programme such as the teaching strategies, the organisational features and the overall study climate.*

After several attempts to carry out focused studies on various aspects of the programmes operated by the Centre (Lewy 1981; Botha 1987) a need was felt to coordinate a series of studies to yield comprehensive evaluative information about the major projects of the Centre.

Such studies are designed to serve the following aims:

- ❑ Provide information which may lead to a better understanding of the activities of the Centre.
- ❑ Review activities to identify areas in which shortcomings exist or desired performance has not been attained.
- ❑ Promote decision making on alternative courses of action.
- ❑ Identify effective courses of action and programme components. In other words, point out what "works", and so to decide to continue or discontinue a particular course of action.
- ❑ Motivate staff members of the Centre to examine their work critically; create an opportunity for discussing the pros and cons of alternative courses of action.
- ❑ Present evidence about the accountability of the Centre.
- ❑ Share information with all interested parties viz. those in charge of similar programmes in South Africa and other educational systems; researchers; clientele of similar programmes about findings which may contribute to their effectiveness.

Some of these aims are derived from the Centre's statement of intent of 11 May, 1989. These aims are stated in very general terms, without being operationally defined. In this respect the studies carried out followed the premises of the responsive evaluation approach as stated by Stake (1985:4349):

> *The essential feature of the approach is a responsiveness to the key issues, especially those held by people on the site. It requires a delay and continuing adaptation of evaluation goal setting and data gathering, while the people responsible for the evaluation become acquainted with the programme and the evaluation context.*

The studies are intended to continue the evaluation activities carried out by the Centre during the past years and take advantage of findings communicated in previous reports (see e.g. Botha 1987) but while the previous studies focused on particular well-defined aspects of current activities and programme components, the studies contained in this volume examine the overall features of the Inset programmes of the Centre.

Theoretical and practical aspects of evaluating action programmes

The professional literature tends to emphasise the atheoretical nature of evaluation. In contrast to research, which is described as aiming to produce knowledge, evaluation is described as aiming to improve action. Indeed, for this reason institutions in charge of social amelioration programmes are frequently reluctant to allocate funds for evaluation studies. Nevertheless there is a growing awareness that evaluation cannot be fully atheoretical, in the same way that programme planning cannot.

Several evaluation experts have brought forward arguments for examining theoretical aspects of action programmes. Campbell (1979) asserts that an understanding of social phenomena cannot rest solely on information from research; research data are necessarily based on, and embedded in, a complex network of implicit and interesting assumptions.

Likewise Morell (1979:84)

> *Programmes which are designed to meet social needs are likely to be far more complex phenomena than one might ideally wish as a target of scientific investigation. Researchers often have the luxury of constraining the phenomena they study in such a way as to simplify the conceptual issues involved in formulating explanations. Although simplification is a necessary element of any research investigation, evaluators are not as free to exercise such options as are many other social researchers. Evaluation almost always involves the study of a complex phenomenon which can be changed in only very limited ways in order to meet the methodological or conceptual requirements of the evaluator. Since the phenomena which are studied by evaluators cannot be simplified by any "internal" manipulation, a kind of conceptual simplicity must be imposed on the phenomena by already existing knowledge and understanding.*

In planning a comphrehensive evaluation programme an effort was made to specify the rationale of the programmes. In dealing with the INSET programme, which is the major project of the Centre, the conceptualisation in planning the evaluation relied on the ideas of Eraut (1985) and Beverley Showers, Bruce Joyce and Barrie Bennet (1987). From the former is adopted the model identifying four INSET paradigms (solving problems, correcting defects, supporting growth, implementing change). This is intended to examine the effectiveness of the Shell programme in these four areas; from the latter the distinction between authors' Field-Defined issues (i.e. issues brought up by the stakeholders of INSET programmes, like the involvement of teachers, the initial enthusiasm for training) and Researcher-Defined issues (such as personal characteristics of the trainees, the content of the training, single concept or skills versus complex teaching strategies).

Emerging evaluation design matched with emerging programme design

As explained above the parameters of the evaluation study have not been defined in advance, since the target of the evaluation itself have also adopted a flexible mode of action. The evaluation study is intended to examine the merits and demerits of various programmes which itself has not adopted, a fixed pattern of action. This flexibility is built into the rationale of the programme. The details of the activities have not been set in advance and decisions about the programme parameters have been by the action committees elected by the participants of the programme. The members of the action committee maintain continual contact with the participants of the programme, strive to ascertain their needs, and forward suggestions about the content of the programme to the staff of the Centre.

This does not mean that the programmes operate quite without guidelines and specifications. Rather they accord with the view of Havelock and Huberman (1977:49) that

> *Openness is likely to come and go in cycles: no system had an infinite capacity to absorb new inputs, and having absorbed one kind of input, a system may require a "closed period" in which it digests the input and readjusts its internal functioning accordingly.*

In our particular case the statement of intent indicates possible programme alternatives. The suggestions of the action committee, the experience accumulated by staff members during a particular programme session and from one session to another, and the information obtained from the evaluation of a particular session may result in material changes in programme details, with the proviso that the programme continues to conform with the mission statement.

The evaluation reports are based on data collected during a period of a whole year. The interaction between the programme and the evaluation study during this period implies that to some extent some guiding principles of *action research* be incorporated into the design of the study (Kemmis 1985). Nevertheless, the evaluation plan has not fully adopted the principles of

action research. The results of the study are to be presented as professional summaries of a descriptive and evaluative nature rather than of a personal report of a researcher of the programme.

Data used

In determining the pattern of data collection attention was paid to:

- The aim of the study
- The resources available for the evaluation study
- The validity of the data

Aim of study

As indicated earlier the evaluation studies were designed to serve multiple purposes. In addition they are to serve the information needs of multiple clienteles. The principal client of the study is the Centre's staff in charge of planning, developing, and implementing the programme. The first five aims listed in the introductory section touch upon areas of the staff's responsibility. Indeed the findings related to these areas will have a bearing on their work.

The last two in the list of aims serve the information needs of other groups, namely the body responsible for supervising the Centre's activities and the educational authorities in charge of running in-service programmes and increasing their efficiency. Consequently, most of the information to be collected derives from the work of the Centre's staff: from a critical analysis of documents produced by the staff as part of their routine work, from their reflective and self-evaluative reports of their own work, and from a systematic examination of written and oral exercises carried out by participants of the various courses.

The data to be used in the study are considered by the staff of the Centre as adequate for answering questions relating to their interest. The appropriateness of the data to the needs of the staff has been validated through analytical examinations of their working schedule and by their individual concurrence.

Resources Available

Evaluators must decide how much information to collect within the framework of a particular study. Decision frequently is determined by whether the study is to be undertaken in depth (upon a narrow field) or broadly (upon various aspects) (Patton 1982). Given the fact that the study is to serve multiple audiences and multiple purposes, it seemed necessary to address the various aspects of the programme. Nevertheless, through careful planning of data collection, an effort was made to satisfactorily examine salient aspects of the programme in sufficient detail. Due to limited resources, it became necessary to reduce the amount of data, but without compromise in regard to the variety of data types to be collected.

Full use has been made of data which were ready to hand - with the added advantage that there was no need to invest resources in gathering them. Such data include curriculum embedded materials. This term, derived from the report on the Individually Prescribed Instruction Programme of LRDC of the University of Pittsburg, (see Lindvall and Cox 1970), refers to evaluation-relevant materials produced as an integral part of the curriculum. A variety of handouts, routine test materials, records of events occurring in class, etc. conform to this description and may serve as an inexpensive and unobtrusive source of information.

In contrast only a small quantity of labour-intensive data were collected and observations were kept to an absolute minimum. The decision to minimise the expense of data collection reflects the commitment of the Centre to a service-oriented policy, as indicated in its mission statement.

Validity of data

It is sufficient to demonstrate that the curriculum embedded data have been actually related to the routine operation of the programme. As to qualitative data such as interview and observation transcripts, their validity was examined through the technique of triangulation. Denzin (1978) defined triangulation as an examination of the consistency of information derived from various sources. Denzin distinguished between triangulation of four types: data triangulation; investigator triangulation; theory triangulation; and methodological triangulation. In this study we rely on triangulation of two types:

- **Data triangulation** - referring to the fact that data were collected from various groups of persons such as teachers, tutors, coordinators, and school principals, whose involvement in the programme may generate different conceptions of events.
- **Methodological triangulation** - referring to the fact that information about a single event or occurrence was collected through various methods, such as archival data, interview, observation.

Data types

Five main data types, namely: archival data, course embedded products, interviews, observations, test surrogates and questionnaires are used in the evaluation.

Archival data

During the process of programme planning, development, and utilisation a variety of documents are produced which usually become filed in the archives of the programme. Previously we referred to such information sources as curriculum (or course or programme) embedded data, i.e. data which were not created for the purpose of evaluation but, since they are considered essential for running the programme, are available anyway.

Some of these data have been routinely produced in the past; such as attendance reports, minutes; others have probably not - inclusion in the list of archival data implies that such documents should be routinely produced without regard to whether a formal evaluation is carried out or not.

Course-embedded products

Both archival documents and course embedded products are routine by-products of programme processes. The archival data are limited to the making of decisions about the content of the programme, the preparation or selection of instructional materials, and the determination of some organisation characteristics of the programme.

Data classed as category of course-embedded products are derived from actual learning experiences taking place within the framework of various courses and from the impact of these courses on the practice of teachers participating in the course.

Interviews

Interviews were planned with three groups of stakeholders of the programme: teachers, tutors, and project coordinators. The interviews are anticipated to be semi-structured.

The interview is one of the most valuable information sources for evaluation studies of this type. As indicated by Patton (1987) interviews provide information about aspects of the programme which cannot be directly observed. They help to reveal the meaning attached by the various stakeholders of the programme to events, and also the opinions of people about the programme in general and specific components in particular. The use of probing questions in the interview may afford information about expected reactions to hypothetical situations which may emerge.

Observations

Observation in educational settings has a long history. For centuries school inspectors visited teachers to evaluate their teaching performance. Systematic observation (observation of predetermined characteristics of a lesson, producing factual data of relatively high objectivity and summarised by quantitative techniques) has a history of less than a century. (Medley and Mitzel 1963). Since the beginning of the twentieth century hundreds of systematic observation schemes have been produced, the most important being reproduced in the monumental work of Simon and Boyer (1967, 1969, 1970). One of the best known and most used systematic observation scheme is Flander's (1970) Interaction Analysis Form. Flanders developed a technique of describing a lesson's profile through quantitative representation of various types of pupil/teacher verbal interaction, like the proportion of time devoted to answering pupils' questions or to providing positive or negative feedback to pupils, etc. In this study we moved away from the 80 year old tradition of systematic observation and collected information by using the technique of systematic observation and collected information by using the technique of holistic observation, which lends itself to qualitative rather than quantitative analysis.

As an instrument of observation the Narrative Model, in which all salient events of the class are chronologically described and the transcripts describing the class events contain time signs (for example, at each ten minutes a figure is inserted in the margin of the recorded text) signalling how much time was devoted to a particular event (Stallings and Mohlman 1985) is used. While this appear to be an easy task, in fact there is a need for meticulous training of persons carrying out such observation.

Observations were planned to be carried out in different settings. Particular INSET events will be observed, and also conferences of the action committees. The first will provide information about the quality of tutors' work in the INSET programme and about teachers' interest and participation in the lesson. The second will provide information about the effect of INSET on teachers' performance in their classes.

Questionnaires

There is no need to justify the practice of using questionnaires in evaluation studies of programmes. It is a well-established tradition of the Centre to use both multiple choice and open-ended questionnaires at each programme event, both of which has been intensively utilised in studies requested in this volume.

The relevance of data types to the evaluation criteria

In the previous sections a variety of data types to be used in the evaluation study have been mentioned and in addition four types of evaluation criteria in the service of which the data will be applied. Table 1 contains a summary about the relevance of each data type to the various evaluation criteria.

It can be seen that interview and observation data provide the most comprehensive evaluative information, although probably they do not provide the most reliable or valid evidence about programme effectiveness. The other data types are more specific.

Continuous use of the evaluation findings

The evaluation study is planned in such a way that while data collection is a continuing activity, there is correspondingly a continuing utilisation of the evaluation findings. Unlike evaluation studies carried out by external professional teams producing evaluation results, usually only a long time after the data collection, the collaborative nature of the evaluation study carried out at the Centre enables data to be summarised immediately after its collection and useful recommendations to be made long before publication of the final report of the study.

The ongoing utilisation of data summaries is illustrated in several studies contained in this volume. Thus, for example, Hobden and Lewy present a summary of responses to an INSET evaluation questionnaire. The summary of that questionnaire was carried out as an exploratory exercise for the INSET evaluation study. The procedure described in Hobden and Lewy's article has implications not only for selecting appropriate data summary techniques but also for improving programme activities long before the evaluation study is completed.

Results contained in this volume should be considered as an interim report in an ongoing process of evaluation.

The continuous utilisation of interim results is made possible through continuous collaboration between the project staff and those who dealt with the evaluation. Interim data summaries provide input for staff discussions and shape the attitudes of programme coordinators and implementors to their own work.

It should be noted that the timely provision of interim data summaries is facilitated by employing an evaluator with professional experience and knowledge, and defining his role in the Centre as the promotion of evaluation without imposing upon him responsibilities of programme management.

It would be desirable to separate the responsibility for running the programme and that for running the evaluation study. Both responsibilities are labour-intensive. Programme implementors can contribute much to the evaluation study and without their help it would be impossible to collect required data, but to expect the programme implementor also to manage the evaluating would inevitably lead to the neglect of one of these responsibilities, if not both. In running educational programmes, implementors should always seek to improve the programme, and this cannot be done properly if it is to be combined with conducting the evaluation. This separation of responsibilities may run counter to trends prevailing in South Africa (see e.g. MacDonald 1989), but hitherto no evidence has been produced that these two tasks can be effectively carried out by a single person. The Shell Science and Mathematics Centre considers this challenge as one of its highly important tasks for improving the mode of its operation.

Table 1. Relevance of data to criteria Evaluation criteria

Data types	Interest	Acquisition of knowledge	Teaching behaviour	Achievement of students
Archival data	x			
Programme embedded		x	x	x
Interview	x	x	x	x
Observation	x	x	x	x
Questionnaire	x		x	

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Statement of Intent of the Centre and its Implications for Action

S Hardman

Introduction

The Shell Science Centre was established in 1985 with the aim of redressing "the educational deficiencies and the lack of opportunities in a system which has entrenched unequal and different education for decades" (Botha 1987).

During the six years of the Centre's existence it has operated a number of programmes. Initially these aimed at enriching the curriculum of selected groups of students. Examples of such programmes are the Curriculum Extension Programme, the Matriculation Examination Preparation Programme, and the Winter Schools supported by the Centre.

The second major area of development was in-service education and training (INSET), with the Centre emphasising a democratic rather than a top-down approach to its programmes. The democratic spirit of INSET programmes was embodied in action committees, which assumed responsibility for ascertaining INSET needs and carrying out the work of planning and monitoring the programmes.

Presently the Centre is concentrating on INSET, and student programmes have been discontinued for the time being.

To consolidate the framework of its operation the need was felt by the Centre staff to formulate a statement of intent. The statement contains a formal declaration of the ideals which guide the Centre and its activities (see exhibit 1): "Rooted in the ideals of Shell South Africa (Pty) Limited and the University of Natal, the Centre would like to uplift the 'Black' educational system in Natal to a level which will facilitate its smooth integration into the post-apartheid society" (Botha 1987).

The statement of intent defines the Centre as a group of educationists with support staff and resources. The values of equality of educational opportunity and the development of the individual are promoted through affirmative action. The focus of intervention is upon active support for professional development and on active cooperation with all involved in positive and constructive change in the area of science and mathematics education. The statement recognises and supports the holistic nature of education, while focusing on the abovementioned subjects. Its concluding remark is a clear affirmation of the unwavering political stance of the Trustees of the Centre Trust: "We believe that the development of leaders in the educational communities will bring about change in the educational deficiencies caused by a system that has entrenched unequal and differentiated education."

However, a formal document containing a concise summary of ideas is not in itself sufficient to guide the work of an institution. A statement may be interpreted in different ways and people may differ in their view of the best way to attain a stated goal.

In 1989 the Centre focused on activities designed to convey the purport of the statement of intent to people participating in the Centre's work. Interpretation of the statement and its implications for action were accordingly discussed at the annual conference of the Centre.

In this context it needs to be stated that the Centre has developed "base stations" or regional units in Newcastle, Ladysmith, Port Shepstone, KwaMbonambi, and Greytown. The units are staffed by part-time administrators. Through close cooperation with local educationists, unit management committees were established and in the months preceding the conference action committees for the different subjects were elected in most of the units. The aim here was to devolve responsibility for establishing programmes in a subject from the Centre staff to the local subject action committees. Thus a step towards the realisation of the statement intent's in regard to INSET as sponsored by the Centre had been taken before the conference.

The conference delegates comprised the chairman of the various action committees together with the chairmen of the unit management committee and the part-time administrators appointed to the units.

At the conference itself the statement of intent was examined in three ways:

- There was a formal presentation followed by open discussion.
- The statement was used as a resource document in subject programme planning sessions.
- The responses to a questionnaire handed out at the conference were examined.

The conference plan
A conference has been held each year to bring together the management committees of the various units. The conference provides direction for the units and clarifies the short-term goals of the Centre.

The 1989 conference agenda was an ambitious one in that it concentrated on realisation of the statement of intent and entrenching the Centre as an intervention agent.

The activities of the conference consisted of two plenary sessions and two subject group sessions. In the first open session the statement of intent was presented and discussed.

Administration of the questionnaire at the end of the conference
An evaluation questionnaire was given out to all delegates and was collected at the end of the conference.

The questionnaire provided delegates with an opportunity to express their thoughts about the Centre. The questions themselves were informal and enabled the delegates to express themselves freely.

The questions and responses and the implications for the Centre

The first question examined the delegates' views on what activities they believed should be given priority by the Centre. The activities in the statement of intent under the title "What is the focus of the Centre's activities?" were used as a list to select from. The first item in the list (professional development of teachers) was excluded as it was hoped that the reasons given for their choices would throw light on the delegates's perceptions of professional development.

The 35 choices made by the 28 respondents were distributed as follows:

- ☆ Provision of resources (14 choices)
- ☆ Community education programmes (10 choices)
- ☆ Curriculum development (7 choices)
- ☆ Communication and coordination (4 choices)
- ☆ Supporting groups involved in science and mathematics education (no choices)

It is of interest to note that the highest number of choices was made for the aspect most important to the teacher in the classroom and the lowest for activities which most probably typify the ideals of the Centre and are professional tasks.

Respondents were also requested to justify their preferences. Responses were found to be expressed in terms either of teacher needs or of the teachers' perception of the Centre. Thus in justifying their selection of "provision of resources", "a lack of resources encourages rote learning", "science without a laboratory", while others were to the effect that "providing resources is a practical way of showing that the Centre is interested in teachers' effectiveness and efficiency, and outreach would be translated into practicality".

A further aspect of the question is that it encouraged respondents to consider their response from the standpoint of the Centre. Thus, in connection with provision of resources, the following were used: "improves", "develops...", "assists...", "strengthens...".

However, of these responses justifying participants choice in this category, few answers revealed a concept of the vision of the statement of intent. The most revealing responses were probably the following: "Will make the black child competent enough to compete favourably with anyone else - even with people from other racial groups", "Strengthens the teacher - gives him added confidence and support".

In the case of "communication and coordination amongst different groups working in non-formal education programmes" responses were found to reflect a concept of vision, for example "This will bring about effective change and understanding thus creating mutual trust among groups".

In summary, the delegates' responses tend to suggest that they see the Centre primarily as a provider of resources. From the point of view of teachers in schools experiencing a scarcity of resources this is quite understandable. The responses reveal little grasp of the viewpoint of the Centre - that teachers are themselves change agents in society and that the Centre seeks to assist them to empower themselves in their pursuit of excellence in the classroom.

With regard to teachers' perceptions of the identity of the Centre clearly we should consistently put across the statement of intent as the vision of the Centre and exercise the concepts contained therein through workshop-type activities. It is only once the identity of the Centre is conceptually defined by the clientele and internalised by them that they will be in a position to relate to the Centre in the manner envisaged by the Centre.

The second question attempted to obtain information from the delegates which would be useful in determining their perception of the relation between the action committees and the Centre staff. These responses would assist Centre staff in identifying key tasks in working with the units.

Responses to this question can be summarised in terms of three categories of support for the associations by the Centre, namely provisioning, visiting, and liaison.

In terms of provisioning the following two suggestions are the most important:

- Transport. A few respondents emphasised the need for transport to be provided to deliver equipment to schools and remove it from schools: "Each unit needs to have its own transport to reach teachers in all five units".
- Libraries. A larger group saw a need to develop unit subject libraries and build up the supply of teaching resources and equipment.

With regard to visiting, respondents requested that the staff of the Centre visit their units. These visits should "promote a free flow of information and a relation of trust and understanding". Many respondents reported "a lack of both horizontal and vertical communication". Emphasis was placed on meetings at unit level, with the following five services expected from Centre staff:

- Explanation of the goals of the Centre and of the practical application of these goals at unit level. Respondents required Centre staff to "provide guidelines for operation"; and that "action committees be assisted in forming clearly defined objectives".
- Evaluation and feedback on current programmes.
- Assistance in problem identification and resolution: "The Centre and its staff should plan regular visits to units to give expert guidance and get to grips with existing hindrances and problems".
- Assistance with conflict resolution within the associations.
- Information about tutors.

Most of the responses, however, were concerned with liaison

- ☆ with departmental officials: to justify the programme and arrange for its accommodation
- ☆ between units and action committees: to form ideas from seeing what others were doing.

A few respondents suggested some form of publication from the Centre as a means of providing information and facilitating communication between the Centre and the network.

From the responses it is clear that the leadership function of the subject coordinators is generally accepted. The demands made on the staff by the units fall into two groups, firstly provisioning the units and secondly visiting and liaising, in which the role the Centre staff play in *communication* is emphasised both for attaining the *objectives* of the intervention programme and for the practical *functioning* of the units, with special reference to their subject committees.

The responses reveal considerable concern on the part of respondents about their role in provisioning their units from the Centre. Experience, however, has shown little initiative on the part of unit committees motivating clearly formulated resolutions on their perceived needs. Rather there is a passive acceptance of equipment received.

Secondly, respondents reveal the attitude described by van den Berg (1987) as "teacher pathology", which hinders teachers from becoming active change agents. As he puts it, "Teachers are generally perceived by the authorities as the recipients of policies determined by their masters, and as the agents of those masters in the docile and loyal implementation of these policies".

Thirdly, the responses reveal considerable confusion among the clientele concerning the "ownership" of the action committees. As the Centre staff were responsible for establishing the committees, it is only natural for them to be perceived as "belonging" to the Centre. The question of the ownership of the committees is complicated by the existence of departmental subject committees, NATU subject associations, and the perceived confusion arising from numerous committees made up from the same group of teachers.

It is clear that the concept of "intervention" needs to be clarified among teachers, principals, and departmental officials. More specific objectives need to be mapped out so that the meaning of change implied by the Centre's operation is clearly understood. Change refers to teachers' participating in INSET adjusting from passive consumption of INSET in a top-down model to active participation in a democratic and interactive setting.

The funding of the action committees needs to be explained in line with this approach so as to remove the apparent conflict between having the programmes democratically planned at unit level but approved by Centre staff.

The final question required respondents to record any problems arising from the programme of the Centre and its structure.

A summary of the responses reveal that problems occur:

- ☆ in the functioning of the programme
- ☆ between the programme and its users
- ☆ between the programme and the departments of education

With regard to the functioning of the programme, the following problems are found:

- ☆ a feeling by some of the clientele that they are not sufficiently involved in the decision-making process
- ☆ perceived unfair dispersion of teaching equipment
- ☆ lack of dissemination of information within the units
- ☆ insufficient transport
- ☆ unclear policies and plans
- ☆ unclear job description of subject committee chairman

Between the programme and its users:

- ☆ teachers do not know what we are hoping to achieve
- ☆ principals do not know what is going on
- ☆ part-time unit administrators are in dual employment
- ☆ subject committees are unclear about their function.

Problems identified between the Centre and the departments of education are that:

- ☆ principals are affected by staff absence through course attendance
- ☆ authorities feel threatened
- ☆ departments do not cooperate in advertising programmes.

In reflecting on these responses it should be borne in mind that as our intervention programme seeks to bring about improvement and change within the entrenched system, it might be expected to encounter numerous difficulties and problems. This is the result of challenging, through our existence, the authority patterns and relationships of the status quo. The biggest problems are accordingly expected to arise between the programme and its users and between the programme staff and the departments of education.

The Centre staff consistently articulate the view that no teachers serving the departments "belong" to the Shell network. The view is expressed that the opposite is truer. Once again it appears that educators are uneasy with a programme which challenges their concept of subjective reality.

Reflection on the major issues highlighted

In reflecting on the information provided by the questionnaires, four issues stand out. These have to do with identity, ownership, relationships, and operations.

Identity

By the identify or perceived identify of an organisation or an institution is meant who does what, when, and why.

The teachers served by the Centre, as also teacher organisations and departmental officials, have difficulty in answering these questions for themselves and see the Centre as a somewhat novel entity. Consequently the agenda of the Centre is perceived as unclear.

Teachers need to be informed of the existence of teachers' centres and the kind of work they carry out. They probably also need to understand the added complexity of the Shell Centre having to take a policy stand as reflected in the statement of intent which conflicts with that of the official educational establishment in South Africa at present. Thus, a significant aspect of the Centre is that it operates as a catalyst for change.

At present, intervention is aimed at assisting teachers to take an active part in their own professional development, particularly through their democratic participating in the planning and running of INSET and the freedom to associate with teachers in other departments in the exercise of this activity.

Nevertheless a clearer view of the identity of the Centre needs to be projected to its clients.

Ownership

An aspect of ownership is the right to make decisions concerning action or to determine long-term and short-term policy. In the context of the Shell Science Centre the question is whether the programmes are "owned" by those who provide resources or by those who use the resources. In this regard, Thembela (1987) stresses the fundamental need for teachers to participate in their own self-development. This has also been stressed by the Centre, particularly since 1987, although the context of ownership has been left open to a larger degree than advocated by Thembela.

In the subject action committees initiated by the Centre emphasis has been placed on the need for the programmes of the Shell Science and Mathematics Resource Centre Educational Trust to be perceived by the teachers of the subject associations as belonging to themselves.

There has been a conflict between the programmes' being owned by the user group and their needing to be approved by the Centre subject coordinators while drawing teachers from various departments. It was decided that once programmes were registered they were "owned" by the teachers who participate in them.

Relationships

No institution can carry out its task in a vacuum. An institution operates in a context in which other organisations strive to realise ideals which could either reinforce or inhibit its operations. This is especially true in education, where there are several interested parties: parents, community, church, school, department, and teacher organisations.

The Centre staff were aware before the conference of the need to clarify certain relationships, including those between subject committees and Centre staff; and between the Centre and the departments of education and their subject committees as well as the teacher associations of NATU. This issue has not been clarified before the conference although a tentative decision was made that we needed to be cautious in negotiating around these relationships until we have thought out a conceptual framework.

The question of the relation between parties in education, with particular reference to INSET in South Africa, is fraught with problems and inconsistencies, as highlighted by Hartshorne (1987). Hartshorne mentions that each education authority is acting independently according to its own view of the objectives of INSET. Further, little INSET activity is coordinated and teachers have little say concerning their involvement.

Operation

It often happens that the best intentions of programmes fail because participants are unaware of the mechanics of operation. This is particularly so when staff appointments have recently been made and the responsibility for programme proposals has shifted firmly towards the clientele of the Centre. Operational procedures needs to be spelled out in some form of guide for unit management as the clientele reveals a need for constant and consistent support from the Centre staff at this stage of the intervention programme. It appears that all staff need to see themselves as facilitators of implementation.

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EXHIBIT 1

The Shell Science and Mathematics Resource Centre Educational Trust: Statement of Intent

What is the Centre?

It is a science and mathematics education resource Centre, created in 1985 by Shell South Africa (Pty) Ltd and is administered by a Trust. The Centre is autonomous and is located on the campus of the University of Natal.

The Centre consists of a group of educationists with support staff and resources.

What values does the Centre uphold?

- **Equality of educational opportunity**

  We believe in
  - ☆ empowering individuals to overcome the impediments to equality
  - ☆ affirmative action

- **Development of individuals**

  We believe
  - ☆ that individuals must take responsibility for their own professional development
  - ☆ in democratic participating of the individuals
  - ☆ that ownership of programmes resides with the participant/user and the community in which he/she operates

What is the focus of the Centre's activities?

- ☆ Professional development of teacher, including the managerial skills of head teachers
- ☆ provision of resources
- ☆ curriculum development
- ☆ supporting groups involved in science and mathematics education
- ☆ communication and coordination amongst different groups working in non-formal education programmes
- ☆ community education programmes to inculcate a love of mathematics and science

How do we do this?

We do this through
- ☆ developing innovative programmes
- ☆ research and evaluation
- ☆ provision of support and facilities
- ☆ specialist Inset courses
- ☆ consultation
- ☆ generation of resources and helping teachers produce their own resources
- ☆ developing skills and leadership qualities
- ☆ acting as a catalyst to promote science and mathematics education and those other subjects which facilitate the learning and teaching of these subjects.

Why does the Centre operate in this way?

We believe that the development of leaders in the educational communities will bring about change in the educational deficiencies caused by a system that has entrenched unequal and differentiated education.

INSET Programmes

PHYSICAL SCIENCE

P. Hobden

Introduction

The science INSET programme is coordinated by a team consisting of two science educators and a technical assistant. Individual INSET events are planned by regional action committees consisting of teacher representatives. The science team assists the committee in adjusting requests so that the workshops and other activities can be implemented.

This physical science INSET report consists of a series of articles on different aspects of the programme. The rationale provides some idea of the aims and purposes of the programme. This is followed by a descriptive report of an INSET workshop by a centre coordinator illustrative of the more innovative teaching methods employed. The third article, by an external evaluator provides an observer's perspective of the dynamics of two workshops attended. Thereafter, a 3-day INSET course is evaluated for the purpose of future planning. This report also discusses the use in evaluation of qualitative evaluation data obtained from teachers and outlines the evaluation method. Finally, an article on a supportive programme, namely the Labroratory Development Project is included.

Physical Science INSET Rationale

P. Hobden

Purpose of the INSET Programme

The INSET programme has been planned with a number of objectives in mind, primarily

- improving teachers' skills and knowledge by providing them with an opportunity to develop their understanding of basic concepts
- meeting the needs of the matriculation system by assisting teachers in preparing their pupils more effectively for the examination
- preparing teacher groups for new roles in a changing society by developing effective leadership skills and changing attitudes

The first objective addresses itself to shortcomings in the knowledge and skills of teachers who are underqualified or have experienced limited teacher training. The second meets the needs of the present examination system while the third is more for the personal professional development of teachers.

Assumptions

Many INSET programmes are criticised for a lack of direction. Research indicates that programmes based on some described conceptual model tend to be more successful (Orlich 1987). For this reason decisions were made about the INSET courses in a planned and systematic way on the basis of a model or set of basic assumptions about the process of change in teacher behaviour. Orlich's (1987) assumptions for an "educator centre model" were adopted:

- fundamental reform comes only through the teachers, who must implement the reform
- teachers are unlikely to change how they teach simply because they are told to do so
- teachers take reform seriously only when they define their problems, determine their needs, and voluntarily seek help

Implementation

To ensure that there is a reasonable chance of success, the following strategies, grouped under the headings of organisation and content selection, are adhered to in planning individual workshops and activities.

The organisational strategy requires that activities be planned as a *collaborative* effort on the part of all those involved in and affected by the programme. To this end action committees, elected by participants in the programmes, plan the INSET workshops assisted by staff of the centre. Members of the teacher group volunteer to lead sessions, giving them a chance to act not only as learners but also as leaders. This results in greater social cohesion and gives teachers a chance to share their views (Showers et al. 1987). The programme allows teachers to *choose* the activities in which they wish to participate. Workshops are voluntary. The programme includes an *evaluation* component. The data collected is made available to the committees to assist in their planning.

As far as content selection strategies are concerned, INSET activities are firstly *school focused*, that is they take into account conditions in schools and the reality of current disruption of the normal school programme. The programme also *models* good teaching practice through the application of general principles of learning. It is considered important that teachers experience effective teaching strategies themselves, on which to model their own classroom practice. Lastly, the programme is not trivial and routine, but rather ambitious and extending.

Teaching and learning strategies

As indicated above, the programme aims to provide teaching models that it is hoped teachers will adopt. These should be innovative and not follow the very common practice of science teachers (Renner 1982) of introduction to the topic or "experiment" followed by an activity such as a demonstration or verification experiment. This would then be followed by application of knowledge by answering textbook type quantitative questions in preparation for a test. The practice of centre workshops is based on the constructivist view of learning (Osborne and Freyberg 1985) which has four main steps: eliciting students' existing ideas; providing restructuring experiences; providing opportunities to apply new ideas; and reviewing any changes in ideas.

Where centre coordinators are involved in the teaching, the teaching method takes into account the existing concepts of the learner. They do not assume that knowledge is transferred intact from the mind of the lecturer to the teachers or that the initial ideas of teachers are easily changed to

more useful concepts or to the "scientific view". Where teachers are responsible for the sessions, they are encouraged to take into account the above-mentioned models, although it is seen in practice that they tend to revert to traditional practice.

The conditions in schools are such that teachers must teach large classes. Consequently, the teacher group is broken up into smaller cooperative groups (Johnson and Johnson 1989). This is seen as an effective strategy for dealing with large classes. The following elements are encouraged within the groups: positive interdependence; face-to-face promotive interaction; individual accountability; group evaluation; and social skills for group interaction. Teachers are encouraged to use this teaching technique when working in their own classrooms. Use of this technique encourages a sense of responsibility for the learning of colleagues rather than an attitude of every man for himself.

Another activity seen as a powerful tool for learning is the construction of concept maps (Novick 1984) by participants as probes and advance organisers. Teachers are taught how to make these graphical representations of the concepts and relationships they possess. These provide them with evidence of their own prior meaningful learning or a summary of learning if used at the end of a session. Teachers are encouraged to use this activity with pupils due to growing evidence of its value (Ault 1985).

Practical activities are arranged for all INSET workshops. Teachers are very anxious to do practical work. It gives them the opportunity of becoming familiar with the practicals that they have to demonstrate. They also believe that they can learn effectively from these experiences. Unfortunately it is not clear what is being achieved in the present circumstances by practical activities due to an extensive literature which questions their role and effectiveness (Kempa 1988).

Coordinators feel that it is more the discussion surrounding the practical and the "talking through" of the activity that is important. Many examination questions are practical-based and there is a need to strengthen the connections between written problems and practical activities. Consequently much time is allocated to post-practical discussion even though teachers do not always utilise the time effectively. It is also believed that there is value in repeating the same practicals on different occasions. This enables teachers to become very confident of their ability to demonstrate effectively in their classroom.

Resources and equipment are made available for teachers to use, for example videos of practical work that teachers should be doing. Teachers may also borrow an OHP for the year for use in their own classrooms. Teachers can see that we are offering not only INSET but resources to implement the new learning they return to school with. An attempt is being made to overcome the disadvantages inherent in the education system and create conditions for professional practice.

Programme evaluation

Each INSET event incorporates some form of evaluation. In some a questionnaire might be used, in others short multiple-choice questions, in others interviews either formal or informal. The data collected are discussed by the Centre science team and the action committees. Based on this continuous evaluation, decisions are made for continuing, discontinuing, or adapting aspects of the workshops. The satisfaction expressed by teachers in workshop activities is considered together with the manner in which workshop materials were used.

One aspect of the evaluation that requires more follow-up is the extent to which the teachers made use of their new learning in their own classrooms. Because involvement in all activities is voluntary, coordinators are reluctant to visit classrooms unless invited. Another factor inhibiting school visits is the impression teachers have of classroom observation as being "inspections". With the increasing confidence teachers have that Centre staff are not linked or associated, however tenuously, with the departmental inspectorate, school visits will become a regular part of the programme. The purpose will be not only for feedback on practice but to help coach teachers in innovative methods in their own classroom environment, the value of which has been highlighted by Showers et al (1987).

Long-Term Development

There are approximately 250 physical science teachers who could be considered the primary target of the Centre's science INSET. Of these about half attend more than one INSET event at one of the six network centres in Natal/KwaZulu. Attendance at a typical workshop in the Durban area would be 20-25 on Friday, dropping to 15 on Saturday. This represents approximately 30% of those on the mailing list. Because the workshops encourage small group work and practical work, it would be difficult to cope with more participants. Consequently little is done to encourage those who do not attend. However, every effort is made to increase the size of the core (approxi-

mately 8-12 teachers in each region) who attend most sessions.

Teachers do not have an opportunity for meeting on a regular basis other than that provided by Centre workshops. These meetings offer opportunities for teachers to communicate and for the dissemination of much information that would normally be the task of an education department advisory service. Examples of information only accessible through these meetings to 80% of participants are details of the examinable practicals ("64 experiments"), the format of the examination paper, examination marking memoranda, and trial examination papers for pupils. Consequently the INSET programme meets crucial needs other than those directly related to the science content taught.

The workshops started by following a 2-year cycle of topics to be covered. The syllabus was new and teachers were introduced to topics in the month before teaching it to their pupils. Since the first cycle was completed the action committees have tended to choose smaller sections of work from both the standard 9 and 10 syllabuses to meet the needs of as many teachers as possible, for example vectors on Friday and Ohm's law on Saturday. This is not always successful due to the large amount of material to be covered which leaves little time for discussion and practice.

Over the last few years the programme has concentrated on providing teachers with a basic level of knowledge (overcoming the deficit in their initial teacher training) together with elements of development. Now that most topics have been covered at least twice, there is a movement to focusing on "How I teach" rather than just giving teachers basic content knowledge. Other formal diploma courses have been introduced by the Centre in cooperation with the University to cope with the deficit while the centre programme of workshops will meet the needs more and more of "development". The emphasis will change to learning innovations and strategies. The attitude that will be emphasised is one of life-long learning and professional development.

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Descriptive Report on a Physical Science INSET Workshop

P. Hobden

This workshop, held on 20/21 April 1990 at University of Natal, was the third of seven sessions planned for teachers by the Durban physical science action committee. Two had already been held earlier in the year and for this workshop invitations were sent to all known physical science teachers working in "black" schools in Durban and surrounding areas.

The turnout for the course was a little disappointing. It was expected that approximately 25 teachers would attend. However, only 14 arrived on Friday plus 4 others on Saturday. Besides teachers not wanting to attend or being allowed to attend, two possible reasons were unrest in schools because of pupil funerals and the teacher protest meetings taking place on the Friday; and the request by the action committee for the first time for teachers not to use the hotel accommodation unless they lived outside Durban, because of the high cost. Use of the overnight stay at the hotel fell from an average of 18 teachers previously to only 5. Ten of the teachers who stayed in the hotel previously did not attend on this occasion. Perhaps this indicates the importance, to some participants, of the overnight stay at the hotel as part of the workshop.

The workshop was held as usual at the University in Studio 2, a large workshop area, making it possible for teachers to spread out and work in groups. The tables were a bit large for the small groups, but adequate especially as they could also be used for practical work. The lunch and tea were prepared on the outside verandah. Besides the clatter of cups and saucers at certain times and noise from the traffic, the venue was relatively quiet compared to normal classroom environments.

Programme Events

The programme deviated significantly from that planned by the action committee. The facilitator invited to run the workshop was not available to lead the workshop, so it was planned to have some of the teachers from the action committee act as leaders. However, the teachers did not arrive for various reasons, one calling in briefly to apologise as pupils had requested him to attend the funeral of a school pupil. Consequently, as I had previous experience of running a workshop with the same materials, I led the group. The materials were those used previously at a Michaelhouse course so there was little to do except guide the small groups as they worked through the materials and facilitate report-back sessions.

On the Saturday, participants continued with the electricity programme. This had been anticipated by centre coordinators, but the committee had planned other inputs (exhibit 1), not expecting teachers to spend so much time on the electricity materials. None of the standard 9 teachers chose to change from electricity to inorganic chemistry (the section prepared specifically for them), which some were teaching at that time at school. There was not even enough time to attend to solving many examination-type electricity problems, as planned.

Learning Activities

In previous workshops participants had been introduced to the idea of working as cooperative groups. They had difficulty in adapting to this way of organising group work, in which individuals were assigned roles and had to help each other to master the material by monitoring each other's learning. Despite the difficulties of "consumer resistance" this workshop was continued using this arrangement. Centre coordinators, when working with groups, would remind participants and encourage them to use the cooperative strategies.

The materials (exhibit 3), designed by a researcher (David Brookes, UDW 1989) in the field of pupil misconception in electricity, required teachers to respond to a series of simple theoretical problems by making predictions, then followed this up with the actual circuit constructions. In most cases the resultant observations were in conflict with their expected observations and thinking. After making sense of their observations by group discussion, participating teachers had to summarise their learning in writing, (for some sections using concept maps) for future reference and report-back sessions.

Teachers were asked to write down their predictions, explanations and summaries in simple terms as if they were explaining to their own

pupils. This was resisted in a few cases, perhaps because of poor English language abilities, but most groups actually produced written explanations of the phenomena studied. Some of the report-back sessions involved teachers debating the correctness of certain explanations, or how to use them at school. Teachers were for the most part very involved in learning, with very little time spent on input lectures. Overall the workshop was organised and run on constructivist lines.

The following boxed insert is another example of how these techniques are implemented in the workshops.

Dealing with alternative conceptions of chemical equilibrium

Zuziwe Mthembu

A test and remedial exercises had been constructed as a tool for investigating misconceptions (or alternative frameworks) as part of a research project (Brand 1989).

The distractors were some of the more common alternative ideas held by students extracted from the research literature. The teachers were requested to work as individuals, so that each one could discover his or her own weaknesses. On completing the test, a memorandum was distributed to each one to check their performance and note their shortcomings or where their ideas conflicted with the accepted answers.

The test scores were not collected by the coordinators because teachers are hesitant about anyone seeing their performance, a circumstance that may lead to an unpleasant atmosphere.

To provide some ideas of the steps involved in the use of the test as a teaching strategy the treatment of one question will be described. This requires teachers to choose the closed systems from a choice of three options presented (exhibit 1). The teachers discussed their responses in groups, when it became clear that they had not problems in making decisions about situations I and III. In the former they spoke of an outlet for the gas product, which could leave the system, and were very confident that this was open system. The same reasoning was used for the latter situation. This was recognised as being a closed system because there were no openings for products or reactants to except through in the sealed syringe. It was surmised that teachers were thinking very much in terms of physically closed vessels for a closed system.

The misconception held by teachers was disclosed by listening to their explanations of situation II, which, although the reaction was not in a closed vessel, was to all intents and purposes a closed system because the atmosphere acted as a lid. Nearly all teachers felt that this could not be a closed system: reactants *could* escape because there was no "lid". They had not considered the reaction (or medium) as one which did not produce volatile products. They were making decisions based on only one factor - whether it was a physically closed reaction vessel.

Teachers were directed to a page of explanatory notes showing the importance of considering other factors, including the idea that in open test tubes and containers the atmosphere could act as a "lid".

A number of examples with "correct" descriptions were provided followed by a page of practice examples. Once teachers had been introduced to this new idea, they had no trouble with the practice example, in most cases scoring 100% on these remedial exercises. Comments such as "I never thought about it like that" or "Why do the textbooks not say this?" were common when discussing this concept with the groups.

The effectiveness of using this technique of multiple-choice questions with distractors representing common alternative conceptions is evident. The technique makes teachers aware at an early stage that their ideas do not match those commonly considered correct in "school science" (they get the answers wrong!). They are quickly focused onto their own ideas, which are causing conflict. When exposed to reasonable alternatives, they readily adopt the new idea and learn to apply it fluently in new situations.If the strategy had not been used, teachers might have been brought to positions where their alternative concept could block or interfere with further meaningful learning. Because a prepared instrument was used covering most of the commonly found alternative concepts, together with remedial exercises, teachers were able in most cases to resolve conflict quickly and continue with further meaningful learning.

References

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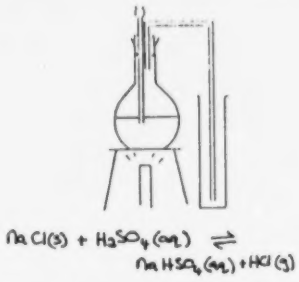
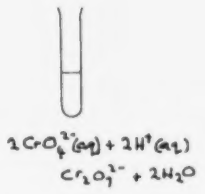
QUESTION 11

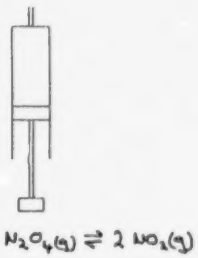
Which of the following reactions is/are occuring in a closed system



I) The production of hydrogen chloride gas, using the apparatus in the sketch, from salt and sulphuric acid.



II) The reaction, in a test tube, of chromate ions in acid to form dichromate ions.



III) The reaction, in a sealed gas syringe, of NO2 to form N2O2.

A) I only B) III only C) I & II only D) I & III only E) I, II & III

Exhibit 1. A multiple choice question on closed and open systems

The level of participation was pleasing. The use of cooperative groups meant that more teachers were actively involved in personal learning and acting as peer tutors, as opposed to some INSET events, where they spend most of the time listening to tutors or watching colleagues do the work.

Many discussions between group members were animated, and when predictions did not materialise the participants were very interested in working out rational arguments. Some, who were not that persistent or more used to other INSET methods, tried to get tutors to give answers, but this was resisted until an answer or prediction has been attempted and written down by the group members.

Critical Review

Overall the course was a success. It was unfortunate that more teachers were not present. The sustained manner in which the teachers interacted was most pleasing. Possibly many had never appreciated till then how much "thinking and talking through" was required to gain understanding of basic concepts. It was hoped that they would now allow their pupils the same opportunity that they had experienced.

The apparent lack of basic knowledge - or rather ability to verbalise their knowledge - was a disturbing factor. Teachers had great difficulty in giving a simple explanations for some events, for example that with two bulbs 1 & 2 in series, when 3 was added in parallel to 2, 1 got brighter against all their predictions! (Exhibit 3) The language they used to explain many phenomena would have confused most, never mind their pupils learning science in a second language. For this reason and the lessons of previous experience emphasis was placed on making teachers write down their explanations. This was seen as a stage in the process of learning in which teachers could see their contradictions in writing, and omissions could be challenged and teachers made to think again.

It was felt that workshop materials needed to be revised to allow future workshops to flow more smoothly. They required some form of introduction which would let the learner know "where they will be going", followed at the end of each section by an opportunity to bring together the results of the last few questions and make a summary. It was felt at times that teachers had answered the questions but not made the links required to previous learning or for future learning.

There were problems with some of the practicals associated with Joule's law. The equipment was not identical to that mentioned in the instructions and when teachers attempted the practical, they could not obtain a full set of readings and a rheostat burnt out. This was an unfortunate mistake on the part of the coordinators, as everything should be done to avoid reinforcing the impression held by some teachers that it is difficult to get "pracs to work".

It has already been observed that this workshop was a repetition of some sections of topics previous studied: this workshop was also done in 1989, then at Michaelhouse in January 1990. From the level of understanding evident from the teachers' questions and discussions, there is still a need to repeat this section albeit in a different form or with another approach to give teachers further opportunities to practise and reinforce understanding.

Programme for Physical Science Inset 20 - 21 April 1990

	FRIDAY: 20 April	
88h30 - 09h00	Registration	
09h00 - 10h00	Work Energy Power problem-solving	Rodger / Bekela / Patricia
10h00 - 10h15	Tea	
10h15 - 12h30	Electricity	Michael / Thulani
12h30 - 13h00	Lunch	
13h00 - 15h00	Electricity	
	SATURDAY: 21 April	
08h30 - 10h00	Electricity Cont	Thulani / Thaboni / Mrs Msimang
10h00 - 10h15	Tea	
10h15 - 11h00	Problem - solving	
11h00 - 12h30	Graphs of motion	Thulani
12h30 - 13h00	Lunch	
	OR	
08H30 - 12H30	Sulphur and its compounds Experiments	Zuziwe / Paul

Exhibit 2.The planned programme

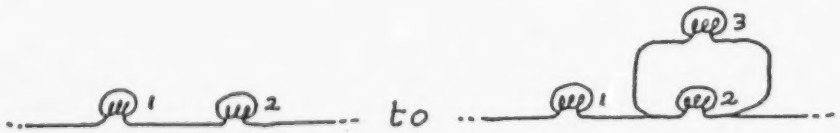
2.2 PARTS OF A CIRCUIT AND THE WHOLE CIRCUIT

One of the hardest things to learn in the study of circuits is that a change in one part may affect all the rest of a circuit.

To illustrate this point two situations have bee given to you to investigate. The first is set as a problem, where you have to predict what will happen and then test the prediction and explain what happens. The second is a simple practical, which, however, needs careful measurement to make sure everything is clearly seen and understood.

PROBLEM

Use two cells in series as a source and connect the circuit as first shown. The bulbs used are all similar. What will happen when bulb 3 is connected in parallel with bulb 2 as shown?



Explain what happens, including any difference between your predictions and what actually happens. Use the space below to record your decisions.

Exhibit 3.Extract from workshop materials

Observation of Physical Science Workshops

E. Russell

Introduction

This evaluation study of the physical science workshops of the Shell Centre was based on observing the whole process of two 2-day INSET occasions. Both INSET workshops were conducted on two consecutive days (Friday and Saturday). The study days were divided into several uninterrupted sequences which are referred to here as "sessions".

The observer kept a narrative record of events (Stalling and Mohlman 1985) and these records served as a basis for summaries of the workshops.

The recordings of each session were analysed according to the proportion of time taken up by seat-work (where participants sat and worked on tasks at a table, either individually or in groups), time used for expository teaching, the use made of teaching aids (overhead projectors, demonstration apparatus, written handout material), the number of questions and requests for feedback to the group by the coordinator and other facilitators, responses by the attending teachers to questions directed at them, the number of questions raised by teachers, the coordinator's (and facilitator's) efforts to "model" effective teaching behaviour, instances of monitoring and correcting the work of participants by the coordinator (and facilitators), the frequency of use made of the "peer-help" system and whether this was elicited or spontaneous, instances of advice or warnings originating from the coordinator (facilitators) and from participants, periods of unorganised time during which no planned activity occurred, appeals for help from participants, use made of delegation, instances of summarisation and consolidation by the coordinator or facilitators, and any other outstanding characteristics of the sessions (use of humour etc.).

A summary based on the analysis of each of the sessions of the workshop was then prepared. Important trends within these summaries were noted, and an overview covering the whole workshop presented.

What follows are the overviews of the two physical science workshops (on 13- 14 October 1989, and 20 - 21 April 1990) and combined impression of both physical science workshops, together with recommendations.

Physical Science Workshop: 13 and 14 October 1989

The workshop was held in the Arts Studio on Level 2 of the Dennis Shepstone Building on the Durban campus of the University of Natal.

In all, the workshop was made up of five sessions. Only for the first of these did the coordinator act as the facilitator. Even this session was opened by two of the five physical science action committee members. Sessions 2 and 5 were facilitated by four action committee members. One of the action committee members facilitated in full, but during sessions 2 and 4 he shared this role with two other action committee members. It was noticeable that he was the most effective of the action committee member facilitators.

A total of 18 teachers attending the workshop. Expository teaching occupied nearly 40% of the time and seat-work approximately 25%. Slightly more time was spent in debate than on seat-work. This bias towards expository teaching was most noticeable during the session in which the coordinator was acting as facilitator. It should be borne in mind, though that he was preparing the ground for the later, more participative, sessions of the workshop.

Some of the facilitators (notably the coordinator and the action committee member who facilitates three of the sessions) stressed the process involved in tackling the problems, while others (particularly the action committee member who started facilitating the second session) appeared more interested in covering the ground they had set for themselves. The coordinator's emphasis on teaching ways to solve the problems, rather than merely the answers to the problems, was conveyed in his statements while engaged in expository teaching.

The approach of the Centre's coordinator was to remain largely in the background and not to dominate the proceedings himself. In this way he encouraged a high level of involvement of the part of the action committee facilitators. Where appropriate he did intervene, but usually with stimulating questions rather than dogmatic statements. In this way the approach employed by the coordinator did provide a positive role model for teachers to emulate.

Much use was made of the overhead projector

and photocopied and other graphic materials. The action committee facilitators seemed to struggle to use the equipment and materials appropriately. Seemingly this was due to their lack of experience in using equipment of this type.

It was clear that the participating teachers interacted more easily with facilitators who were relaxed and confident. Over-assertive or defensive behaviour on the part of a facilitator tended to result in one or two other teachers becoming engaged in a debate with the facilitator to the exclusion of others, who either chatted or looked uncomfortable. Seldom was any resolution achieved to these debates, and participants appeared confused by them.

The teachers attending the programme appeared defensive about their abilities. They did not readily respond to questions from facilitators and a resistance to clearly writing down their answers was evident. This reticence appeared less evident when people worked in groups, where no individual could feel personally "foolish" or inadequate. During this workshop the groups were self-formed and tended to be small and have little cohesion. In a sense this workshop was probably atypical of the physical science workshops in general. It took place just before the end-of-the-year examinations. Teachers and pupils were under tremendous pressure. The action committee had planned a fairly specific agenda that they wished to get through. The whole workshop was fairly strictly goal-orientated. This may have been due to the fact that the schools were in uproar and teachers were subject to extreme environmental handicaps stemming from the violence and the breakdown in school discipline. While these factors are bound to have exercised considerable restraints upon the teachers, they are probably fast becoming the norm, and are likely to continue in the immediate future. During this workshop the peer-help system occurred spontaneously. People moved to seek help and offer advice.

Physical Science Workshop: 20 and 21 April 1990

The workshop took place at the same venue as the other. Twenty teachers in all attended the workshop, although at no stage were all twenty present at the same time. At the start of the second day of the workshop six people from the first day were missing and three who had not attended the opening day joined the workshop. The entrance and exits of teacher provided both a disruption and problems of continuity. The workshop lasted approximately six and a half hours in total.

In contrast with the earlier workshop observed in 1989, the bulk of the time of this workshop was taken up with seat-work. Most of this revolved around the manipulation of electrical circuit demonstration apparatus by groups of teachers attempting to answer pre-set questions. The groups tended to be more cohesive than they had been in the earlier workshop. This might stem from the fact that they were generally slightly larger and thus took on a true group dynamic, and from the demonstration apparatus serving as a focus for the people in the group. Participants did move from one group to another. This sometimes resulted in passionate debate and seemed to stimulate the groups. Movement between groups is positive if it occurs for a short exchange of ideas, but small groups run the risk of disintegrating.

The coordinator acted as facilitator for almost all of the workshop. He was assisted by one other Centre staff member and an associate of the Centre. He delegated authority for certain (mainly procedural) functions to a dominant action committee member. Conscious use was made of the peer-help system by the Shell Centre coordinator. He at times specifically requested an action committee member to assist others. Incidents of peer help also occurred spontaneously. The one action committee member was very dominant and tended to enforce his perceptions upon others. This certainly appeared to have an inhibitory effect on most of the other participants and brought out counter-assertiveness in a few other action committee members.

The open sessions involving everyone at the workshop appeared to be too inhibiting a setting for people to be prepared to make a mistake. Most members tended to keep quiet in these open sessions, but were quite happy to ask the facilitator, or some other member, for assistance when in a group.

Continuity problems were caused by people not attending all the sessions, arriving late or leaving early. Informal periods like tea-time provide people with a chance to socialise. This could be important in reducing their levels of tension and defensiveness, and encouraging easier sharing of problems.

Resistance to making written predictions and writing down answers was again apparent. The participants did not appear to be confident in their knowledge of the subject. Participants appeared confused by the language used in the questions. They were not comfortable with the terminology and appeared to struggle with working out exactly what was required of them. The

coordinator's use of analogy (in this case the traffic on the road in town) appeared to assist in conveying a principle. A tendency for debates to get side-tracked was evident. The debates usually only involved a few of the teachers and did not appear very functional. Most of those present appeared to lose interest in the debates fairly quickly and seemed to want to press on with the programme. The debates thus tended to degenerate into two-way, or at best three-way affairs, with the others as uninterested onlookers.

The Shell coordinator's approach provided a model of effective teaching behaviour for the teachers. He encouraged all present to become involved, chided members of one group for not ensuring that all group members were au fait with what they were doing (getting left behind), insisted that the teachers clearly record their predictions and answers, and checked that the equipment was sound and standardised. He also summarised proceedings and consolidated progress. He provided a framework for conceptualising the process of problem-solving, demonstrated how to use it, and then got participants to try it themselves.

General characterisitic of the Physical Science Workshop and recommendations

During the two workshops a tension between the coordinator's approach, which emphasised methods of teaching in the class, and the preferences of teachers and facilitators, which was to study subject-matter-related contents, was evident. To cope with this tension it seems desirable to separate these two, despite common wisdom to the contrary. Modelling good facilitation is appropriate but it is time consuming and may interfere with content coverage. The workshop fell uncomfortably between the two needs.

It is recommended that action committee members be trained more in the methods of teaching. This may be done by using roleplay exercises. They could then practise what they have learnt in the workshops.

The facilitators of the physical science workshops have been consciously careful to use resource materials that should be commonly available to teachers in their schools. To this end the workshops are located in an arts studio rather than a prepared, equipped laboratory. Notwithstanding this attempt, several teachers complained that their schools did not even have these basic materials. This problem appeared to be most acute with some teachers at KwaZulu schools which are not electrified.

The discrepancy between the resources that the Centre uses in the workshops and what is available to some of the teachers in their working environment can be demoralising. In planning INSET workshops one should consider the fact that the teachers are already faced with coping with other substantial differences between study conditions at workshops and the "real life" classroom. (Note 1)

The most pressing problem in this regard appears to be the very large class size. Breaking the class into groups would appear to be one way that the teachers could overcome the problem. To this end teachers should benefit from more training in effective group work. Having the teachers work in groups is important, but the coordinator (or facilitator) should press even more vigorously for written answers from each group. The observation revealed that teachers are very defensive and resist committing themselves. They do not like to give written or firm answers to questions set. This appears to stem from their insecurity and a lack of confidence in their own abilities. The more competent teachers did not appear as threatened as their less-competent colleagues. Teachers appeared anxious to avoid being 'caught out' or exposed.

During the workshops, topics related to methods of teaching were dealt with mainly through expository teaching, while the seat-work was confined largely to content topics. It seems, however, that more emphasis could be given to the methods topics while in the seat-work setting. It appears that this effort has been made in the past, although it was not evident in the two workshops reported on here, and it appears that it could bear frequent repetition. Teachers appeared to gain much insight from the practical work covered. This was particularly true of the period spent manipulating the electrical circuit apparatus.

The action committee facilitators seemed to struggle to use the equipment and materials effectively. Action committee members could thus benefit from training in the use of educational media. The Centre does make equipment (including overhead projectors) available to teachers who participate in their workshop programme. Few of the teachers appear to make use of this facility, and some are limited in their ability to do so by the fact that their schools are not electrified (mainly KwaZulu).

It was noted earlier that self-formed groups during the first workshop tended to lack cohesion. It might well be that matching people in working groups would be more productive.

Note 1. The Centre makes available multiple sets of the physics apparatus used in workshops for loan by teachers. Unfortunately not all teachers make use of these resources.

Evaluating a 3-Day INSET Programme in Physical Science and Using Qualitative Data for Evaluating INSET Activities

P. Hobden & A. Lewy

Introduction

A 3-day INSET course for physical science teachers, one in a series, was held in June 1989. At the end of the INSET session an open-ended questionnaire was administered to the participants with the aim of evaluating the course. Some of the participants had participated in other INSET activities of the Centre in the past. Fifty-three teachers answered the questionnaire.

The questionnaire contained the following four questions:

1. What did you enjoy most about the course?
2. What did you enjoy least about the course?
3. The aim of this course was to give teachers techniques for teaching their pupils how to solve exam problems.
   Was it a successful course?
4. If you come to another course, what would you like to do on that course?

This article divided into two main parts, summarises participants' views of the course. The first part is a summary report of the teachers responses used for evaluation purposes. The second part describes how this summary report was prepared from the original teacher responses.

The summary of the responses is undertaken to:

- ☆ provide information for organisers of INSET activities that may contribute to the improvement of their programmes;
- ☆ illustrate and discuss the method of preparing a summary of an open-ended questionnaire;
- ☆ examine the effectiveness of using open-ended questions for evaluating the INSET and find ways of increasing their informational value.

PART A

Summary of the Responses in Aid of Improving INSET Programmes

The responses are analysed in terms of course content, course methods, pupils' needs, mutual support, technical arrangements, and preferences for future INSET sessions.

Analysis of comments

Content

Most comments concerned the content of the course. The comments could be classified as indicating enjoyable activities, the success of the course, or drawbacks of the course.

The responses indicated that both cognitive and affective gains were derived from the course. Respondents felt that they gained knowledge: "the course helped us to develop strategies for solving problems", "clarified concepts", or "eliminated misconceptions". Much importance was attributed to practical work, and one respondent wrote that "it is not easy to me since I learnt theoretically. The handout helps to recall what we learnt in the course". The importance of practical work is explained by the fact that outside the INSET framework teachers do not have resources for carrying out practical work. The affective gain is evident in reference to "gaining confidence".

Respondents indicated those content elements which were successfully taught in the course: chemical equilibrium, vectors, charts, electricity, etc. Electricity received mixed ratings. Some found it satisfactory, others rated it "not bad", and still others as weak, at least in comparison to other parts of the course. One component of the programme attracted only negative comments. This was the exercise in which papers were cut. (Questions from past examination papers were cut out and sorted into similar types). Many respondents considered this a waste of time.

Criticism was voiced about repetition ("redundancy"). "The course concentrated on *one* theme

for three days. It was redundant. What applied in the first day to physics was repeated the same day for chemistry," wrote one of the respondents.

Methods of Instruction
Respondents' reference to methods of instruction referred mainly to the course methods themselves and secondarily to teaching skills thereby acquired.

"It was well organised", "We enjoyed the video presentation" are examples of general reactions to this aspect of the programme. Numerous remarks referred to the opportunity for discussing problems with other teachers, but comment of this type will be treated separately under the heading of "mutual support". Praise was given for "the way in which teachers were involved in the actual running of the couse", although no information is provided about the particular nature of this involvement. Participants enjoyed the "freedom to voice problems" and "open discussions and solving scientific problems". Studying examination papers was described as a useful learning activity.

On the negative side the diversity or heterogeneity of the study group was mentioned. A related problem was the integration of new teachers into the study group. Those who had not attended previous meetings "asked too much", and meeting their needs meant a waste of time for those who attended regularly.

One of the most interesting problems encountered in the course concerned the highlight of the session, namely the lecture on the first day of the programme. Although this lecture was mentioned as the most fascinating event of the course, it raised high expectations and set a standard which other learning activities failed to equal.

Pupils' Needs
Since the chief purpose of INSET activities is to help teachers meet the needs of their pupils, it was of interest to see what teachers mentioned about this issue.

Most such references concerned dealing with examinations. One also encounters remarks related to the process of learning: "Making us actually think about the thought process a child goes through when solving questions will help us simplify things when we teach," wrote one teacher; another said "I still believe that if one gives pupils well-organised knowledge on a particular topic this will help them to understand. And if one understands something one will be able to answer all questions under that topic".

Mutual Support
An important function of INSET programmes is to bring teachers together for them to meet, share professional experiences, and support each other in dealing with difficulties encountered in their professional work.

The contribution of INSET programmes to this professional need is strongly acknowledged by several teachers. Teachers mentioned the importance of meeting teachers from other places. One teacher valued the opportunity for correcting flaws in one's work by discussing and working methods with other teachers.

Technical Arrangements
Technical aspects of programmes usually attracts more negative comments than positive ones. Participants overlook the work invested in preparing an INSET event and take it for granted that everything should run smoothly. Only problems come to the fore.

The formal dinner was praised by one of the participants. Another voiced appreciation of the hospitality and everything that the Shell Science Centre did for the teachers. But many comments in this category noted failures to provide adequate accommodation. The perennial complaints about transport were not missing from the list this time either, but the villain of the piece was the weather. Tea had not been served on time, the rooms were cold, and of course time was short. These comments on external forces are balanced by remarks on bad behaviour by teachers, although without details being given.

Preferences for Future INSET sessions
Respondents listed a great variety of things they wanted to see in future events. These touched on mental operations, particular syllabus topics, course organisation, instruction methods, relation between participants, handout distributed, etc.

Such a highly diverse list cannot serve as the sole basis for future planning. The list should be treated as an inventory of perceived needs. Programme planners have to select from the list, and the selection should be based on prevailing trends in science education, and perceptions and principles shared by the programme planners also, and finally on the experience accumulated from previous INSET programmes.

It should be kept in mind that teachers are examminded, wish to participate actively in the programme through discussion, prefer doing practical work which they cannot carry out in their own schools, and like to receive handouts and summaries which enable them to review topics which have been treated in the course.

Summary and Recommendations

A four-item open-ended questionnaire was administered to the participants of a 3-day INSET session in June 1989. Fifty-three persons responded to the questionnaire, and from this approximately 120 different statements were collected and analysed.

The question of what syllabus topics should be dealt with in the future produced a long and diverse list: vectors, equilibrium, static electricity, redox reaction, light, etc. This list cannot serve as the sole basis of planning courses. The responses suggest the need to find an acceptable balance between the conflicting demands of breadth and depth. There is also a need to formulate a policy statement, to be disseminated to participants of courses, setting out the principles which guided the planners in designing the programme.

There was more consensus on course methods. One of the suggestions may well be followed in deciding how much time should be allocated to lecturing and how much to non-expository procedures such as group discussion, experimentation, etc. Consideration should also be given to another suggestion, in this case for creating learning activities which link together the various aspects of a particular topic: theoretical exposition, experiments, and practical work. Other recommendations worth considering are examination-related exercises, analysis of previous exam questions, handouts (pamphlets) containing solved problems, and videos of lessons carried out by teachers in their classes and written criticism of the lessons by peers.

As has been mentioned, one of the lectures had great appeal for the majority of the respondents. This lecture served to open the course and in so doing set a standard. Clearly it is desirable to invite eminent lecturers to open the course, but then the programme should also utilise this opening lesson. Such lectures should be made a topic for discussion, interpretation, etc. and some of the other lessons should build on this introduction. If the lecture does not fit in with the remainder of the course, then it may be better to use it as a concluding session.

The matter of cutting and sorting examination questions requires serious examination. The criticism voiced against this activity by numerous respondents suggests that, in its present form, this exercise and similar ones should be discontinued in forthcoming cycles.

The issue of mutual support was strongly emphasised in the responses, and it deserves further attention. It would be a useful service for the community of teachers if, with the help of the action committee, some activities can be planned to promote the mutual support of teachers outside the framework of the Shell Science Centre's formal INSET sessions as well.

PART B

Preparing a Summary of Responses to Open-ended Questionnaire Items

The data collected for this evaluation of a 3-day INSET programme consisted of responses to a single four-item questionnaire filled out by the respondent during less than an hour. This is not typical of programme evaluation studies, which usually deal with programmes of longer duration and are based on more complex sets of data. Nevertheless such focused studies are important when institutions engaged in operating programmes in recurring cycles want to gather feedback continuously on short components of their overall operation (Lewy 1981). In this section we deal with summarising open-ended responses in an atheoretical way but based on common-sense arguments. A systematic approach based on a particular conception of the change process was worked out by Newlove and Hall (1976). An adaption of that model to the unique situation of a short INSET programme in science teaching is described by Hall and Loucks (1979) and Constable and Long (1988).

The preparation of the summary report consists of three stages: reading the responses; classifying the ideas; summarising the evaluative statements.

Stage One: Reading the Responses

The first step in summarising responses to open-ended questions is to read the responses. The reading should be done by the person who is going to write the summary. (In this instance the evaluator does not have the privilege of transferring this job to an assistant!) In multiple-choice responses coding and computer analysis of the responses are almost clerical work which can be done by semi-trained persons; in the analysis of open-ended responses the reading of the responses is a professional task, and the quality of the work at this stage largely determines the merit of the whole evaluation study.

The reading should proceed according to the sequence of the questions. First one reads all the responses to *one* particular question, then all those of the next question. It is not practical to read through the responses to all questions of a single response sheet.

The reader identifies the ideas contained in the responses and prepares a list of these ideas. There is no need to record the ideas from the response sheet verbatim, although frequently a verbatim record may more faithfully communicate an idea than a brief summary. The reading and the recording of ideas continue, generating new ideas. It is worthwhile to record several different expressions of the same idea. Sometimes stylistic differences represent more than different linguistic habits.

After a certain amount of reading it may happen that nothing new emerges. All remarks become repetitions of what has already been said. This is the sign that there is no need to continue reading. The repertoire of ideas generated by the respondents has become exhausted. The records prepared during the reading of the responses to the INSET questionnaire are presented separately for each question in the appendix.

Stage two: Classifying the Ideas

The second stage starts with reading the list of ideas compiled in the previous stage, and trying to classify them.

This is a task which requires ingenuity and creative thinking. Since those who carry out the evaluation are usually familiar with the aim of the evaluation they may be guided by some preconceptions about the categorisation of the ideas. This is a distracting factor, since the model of classification proposed may reflect the personal bias of the evaluator, but it is unavoidable. In fact, no one can classify statements without being familiar with the topic dealt with in the statement. There are factual constraints to personal biases. The statements should fit into the classification scheme. They need to be uniquely assigned to a category and all items should be contained in one of the categories. Of course one should not demand a perfect fit between the data (i.e. the statements) and the classification scheme and it is permissible for some items to be on the borderline of several categories or even outside all categories. But the majority of statements need to be classifiable according to the categories of the suggested scheme.

One could try to establish the validity of a model through consensus between experts. At least two experts could examine the list of ideas and suggest classification schemes. Congruence or partial congruence among experts may constitute validity, but a compromise achieved among experts is also a satisfactory basis for accepting a model. In practice, however, it is the evaluator, most likely a single person, who selects or creates the model of classification.

Usually the responses to each question of the questionnaire are examined separately, and a separate model developed for responses to each question. In our particular case, one finds interpretation of the ideas listed in various sections, and it seems that a single classification scheme may serve for the responses to all four questions.

In reviewing the ideas in the four lists the following categories were distinguished: selection of content units or content coverage; the method of instruction; the needs of pupils; mutual support of teachers; and technical features of the course.

This list of categories is by no means original, nor is it novel. But it seems to fit the data. It is reminiscent of models, appearing in research literature for evaluating teaching. Thus, for example, Medley (1985) mentions three criteria for evaluating teaching effectiveness: satisfaction with the teaching by those who are taught; teaching behaviour of the teacher; and knowledge acquired by the pupils.

In the model suggested above one may recognise the distinction made also by Medley between the points of view of teachers and their pupils. But the classification scheme suggested here is not derived from Medley's or any other model. It derives from a "common-sense" examination of statements, and quite likely a scheme of this type can be suggested by readers without knowledge or experience of model construction.

In many cases evaluators can rely on a readily available model which serves their purposes, but in most cases they will be better off using their own model or adapting an existing model to their needs.

After deciding on the model to use, one may examine the completeness of the model and ask whether it deals with all important aspect of the programme under evaluation. Are any important features of the programme not mentioned in the responses to the questionnaire items? Are any categories too large? One may decide to split a category into two main categories. A third question which may arise is the relative emphasis put by the respondents on aspects of the programme and the importance for the evaluators or the programme planners of these aspects of the programme.

The final list of categories affords an outline for reporting the results of the evaluation. The keywords appearing in the classification model will serve as subheadings in the evaluation report.

Stage Three: Summarising the Evaluative Statements

The third stage entails a third reading of the comments and at this time the purpose of the reading is twofold: clustering the ideas according to the categories specified in the scheme, and identifying similarities and differences among statements within a single category for creating a qualitative summary of the ideas, and for formulating evaluative statements.

One way of organising the report is to deal separately with each question. The items of the questionnaire are used as major headings for the report. Secondary headings for the subsections of the report would be the keywords of the classification scheme, which may be identical for all questions or for a group of questions, or it differs for each particular question.

Using the questions as an organisational principle for the report is recommended whenever the questionnaire has a small number of items (not more than 4-6 items), and each of them deals with a different aspect of the target of the evaluation. With more items in the questionnaire, it is desirable to group the items under a small number of major headings (again, not more than 4-6) and use these major headings as the basis for organising the content of the report.

In our case it seemed adequate to use a combination of the keywords in the classification scheme and the questionnaire items as the major headings of the report. Of course, any other decision could provide an alternative principle for organising the report.

We decided to pool together the data concerning the first three questions and to deal with the responses to these questions under the major headings derived from the classification theme, and then to deal with the fourth question under a separate major heading.

The mapping of topics represented in the data appears in table 1. The major headings for reporting the results are represented by the keywords appearing in the horizontal dimension of table 1. The resultant report sections contain evaluative comments about five dimensions of the programme. To these headings, one of the keywords from the vertical dimension of the table, namely requests concerning future INSET sessions, was added. It can be claimed that the mixture of keywords from two different classification dimensions of the data represents a logical inconsistency. It may be so. But for the user of the evaluation summary it may be convenient to have the information relating to future INSET programmes in a separate section of the report.

The major headings then for the data summary are: content converage, teaching methods, pupils' needs, mutual support, technical aspects, requests concerning future INSET sessions.

Table 1. The topics of the data Categories

Items	Topic	Content coverage	Teaching methods	Pupils' needs	Mutual support	Technical aspects
1 - 3	Success					
4	Requests					

Using open-ended questionnaires

The reason for using open-ended questions for describing attitudes towards an educational programme, as well as towards other phenomena, is the belief that responses to such questions provide more detailed information than multiple-choice questions. The respondent of multiple-choice questions is led to focus on a specified aspect of the programme, while the respondent to open-ended questionnaires is challenged to consider the programme components as a whole. Answering open-ended questions requires thought, argumentation, reasoning, and specificiation of reasons rather than mere predisposition on the part of respondents to attribute value to a phenomenon. Responses to open-ended questions may help the user of the information to obtain by reconstruction a reasonable understanding of what happened in a particular situation.

Disadvantages of using open-ended items

While the abovementioned reasons may justify use of open-ended questions in many situations, one should be aware that they represent only potential benefits. Quite frequently open-ended questions enable respondents to get away with short responses of little value. Examples of such short response can be found in the appendix.

Sometimes the respondent will be led by the space provided on the answer-sheet to answer full sentences of little informational value. The writing may be tautologous, as in the sentence "The in-service was very successful because we need such in-serve programmes" or "It was very successful because it helps us to improve our work in the school" or "Helps us to deal with problem solving in our class". Such expressions are void of informational value, and reflect a lack of sincere effort on the part of respondents to explain their personal experience. They may reflect compliance with

the demand frequently made by the teacher to their pupils to "please answer in full sentences". The sentence "It was fruitful and worthwhile, because it gave skill to approach certain chapters, so that children understand better", does not tell us what kind of skills they acquired and what kind of problems will they be able to approach later. Moreover, the indication of the particular problem area like "derivation of methods to solve problems especially vectors", useful as it may be, is still far from being completely informative. One would wish the respondent to indicate what kind of problem solving exercises in the field of vectors was found useful, and why. Was it useful because it helped to solve problems which previously the respondent could not solve, or because it offered a better way of solving them? Is the knowledge which respondents acquired in the INSET programme something new or was it a part of the routine training which the respondent had forgotten because it had not been exercised in the course of teaching?

It may be useful to specify in the questionnaire that responses should contain factual information, provide concrete examples, and specify detailed reasons for general statements. Perhaps deterrent and model examples of responses can be included in the introductory section of the questionnaire: "Try to avoid such responses ...", "Here is an example of a helpful response: ...".

In addition to the problems of very short responses or information-deficient ones, a third problem which one may encounter in responses to open-ended questions is the tendency of respondents to be compliant, to agree with what has been given to them by people of higher professional status. Compliance is by no means typical of teachers. In Rudduck's (1981) report on INSET programmes which she evaluated, one may see that British teachers are very critical of some INSET sessions. An exaggerated level of compliance is a characteristic of underqualified teachers, who lack confidence in their own competence, and will attribute their failure to benefit from an INSET programme to their own deficiencies or lack of the necessary knowledge rather than to the poor quality of the programme. Complimentary reactions to a question may also reflect genuine respect for others and a desire to express thanks for the attention given by others to one's needs, even if that attention failed to satisfy the needs. Finally complimentary responses may appear to the respondent as less troublesome than critical ones. Criticism requires justification and argument. Criticism may be challenged, and one may be asked to defend the criticism against counter-argument. Complimentary remarks are much less scrutinised. Answering the question "What did you enjoy?" by a single work "everything", or answering the question "What did you not like?" with "nil" or "nothing" is safer than committing oneself to a comprehensive piece of information.

The problem of compliant responses is not unique to open-ended questions. In multiple-choice questions there is actually an even stronger tendency to mark positive responses. Open-ended questions enable one to respond positively, and also to hint, through one's use of language, at some reservation, a possibility which does not exist in multiple-choice responses. Edwards (1957) referred to the phenomenon of compliance as the "social desirability" effect, and Webb et al. (1965) emphasised the need to use unobtrusive measures.

Nevertheless, the analysis of 53 responses to the evaluation questionnaire proves that, despite the dangers mentioned above, one can learn much from such questionnaires about the weaknesses of a programme or at least about weaknesses as perceived by the respondents. It is true that approximately 28 persons answered the question "What did you like least in the programme?" with "nothing", but at the same time 25 persons specified some weaknesses.

One should remember that summarising open-ended responses is a qualitative and not a quantitative process. It is not a question of a democratic vote, where the voice of the majority is considered to reflect a verdict. In summarising responses to items of this type one has to pay attention to the voice of the minority too, as in fact one should do in democratic voting also. A thorough analysis of critical comments appearing in 53 responses to each of the four questions produces a wealth of information, which may fulfil the purpose of the evaluation and contribute to the improvement of INSET programmes to be carried out in the future.

Moreover, the practice of administering such questionnaires in itself can do much to minimise the recurrence of things which have become a cause for complaint in INSET programmes. Knowing that one's work is evaluated makes a difference to the quality of one's work.

Improving the Measurement Instrument

One of the purposes of this study is to examine the suitability of open-ended questions for evaluating INSET programmes.

Despite the discussed weaknesses of open-ended questions, it has been shown that open-ended questions can provide useful information to a team operating INSET programmes. A series of

recommendations was derived from a qualitative summary of the responses, which may serve as useful input for decision makers.

But our discussion of the summary of the responses suggests that the informational value of the responses may be enhanced if clear instructions and examples are given on avoiding vague answers to questions. Another technique which may increase the informational value of the responses is to formulate questions which cannot be skirted by a short, dead-end answer. One may specify alternatives and ask the respondents to take up positions. An example: "In the next INSET session of one and a half days duration we can deal with the four topics in a superficial way, or we can select two topics and discuss them in depth. The four topics are: ... What is your preference? State your reasons ..."

Finally, it should be noted that the summary of the open-ended questions apprises the programme planners of various concerns of the programme's clientele, and the broad repertoire of issues contained in the responses may afford a basis for developing a multiple-choice questionnaire to serve as an instrument for evaluating courses in the future.

Follow-up of the recommendations

The most important feature of such focused, short-range, and single-instruction evaluation studies, as well as of more complex studies, is their use in improving the programme. However, the formulation of suggestions for improvement by itself does not guarantee that sufficient attention will be paid to the suggestions. The fate of documents is to be kept in office files or catalogued in archives without being put to use. Quite frequently evaluation becomes a ritual and submitting a report is considered an appropriate conclusion of the evaluation study. To ensure that an evaluation report does not remain an archival item, institutions have to build procedures into the framework of their routine operation which will ensure that due attention is paid to such reports.

An evaluation report should be followed up by at least two routine operations. First, the report should be discussed by the team that commissioned the study. Such discussion may take place before the final version of the report is released. In such cases the comments of the team can be incorporated in the final evaluation report. Secondly, a follow-up should examine whether the recommendations have been implemented or not and, if not, why.

Conclusion

This article presents an evaluation report such as may be obtained from the analysis of responses to an open-ended questionnaire. This report appears in the first part of the paper. We then illustrate and discuss the method employed in summarising the responses to the open-ended questions, proposing a sequence of steps to be followed. We also point to one of the weaknesses of such a procedure, namely the inevitability of selecting some response excerpts arbitrarily and disregarding others. It is probable that other evaluators would select other excerpts and come up with other recommendations. Such a level of subjectivity is unavoidable in dealing with qualitative data, and quite likely also in dealing with quantitative data. The evaluators' subjectivity in interpreting data is balanced by guaranteeing access to the whole set of the original data for those who would like to know more than what is contained in the short summary of the data.

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Appendix

Response excerpts to the question: ***What did you enjoy?***

- Well organised, methods we can use, relevant video, free to voice our problems.
- Refresh our mind after work/group work.
- Flow chart appreciated.
- Teaching strategies which make it easy to solve problems.
- To be among other science teachers.
- Expose the way you work to other teachers, they may correct.
- The way we tackled Ohm's law.
- A wide range of exam papers.
- Opportunity given to develop strategy on a wide spectrum of problems.
- The first lecture was profitable.
- Acquired strategies, concepts were clarified.
- Discussing with other teachers the way one can go in teaching pupils.
- Enjoy sharing views.
- Enjoy the way we developed strategies solving chemical equilibrium - Electricity was not bad, but was not interesting enough.
- Fruitful and worthwhile, it gave skill, approach certain chapters, so that children understand better.
- More practical work done, which is not easy to me since I learnt theoretically. The handouts help to recall.
- Derivation of methods to solving problems, especially vectors.
- It focused on both the pupil and teacher. The discussions which take place (including tutors) made it success.
- .I thank Shell to continue with this, so as impose progress and Monday I gained a lot: graphs important in vectors. Tuesday and Wednesday nothing I enjoyed about Physical Science.
- Strategies and use of flow charts.
- The course as a whole covered a very important part of our work as teachers i.e. preparing our students for examination. I like the way in which the teachers were involved in the actual running of the course. I was particularly impressed by the teaching skills which Dr S. gave us on the first day. I would love to meet more people like him.
- I was fascinated by the strategies which were developed for solving certain sections of physical science.
- The most exciting ... we devised strategies how we could help our pupils.
- Flow charts on problem solving; video on electricity, graphical representation of problems to be solved; formal dinner.
- Everything was enjoyable except the cutting of papers, which was waste of time.
- Open discussions about solving scientific problems. Lectures from different personalities. Discussions were open and valuable. Hints about examination. I met colleagues from different places.
- The staff's attitude, the way they handled us.
- Making us actually think about the thought process a child goes through when solving questions will help us simplifying things when we teach.
- I was very much impressed by the way Monday lesson was handled. This does not mean that the other ones were not well handled.
- Through discussions the course cleared a lot of misconceptions. The course was a complete life.

Response excerpts to the question: ***What did you least enjoy?***

- The course concentrated on one theme for three days. It was redundant. What applied the first day to physics was repeated the second day for chemistry.
- The cutting questions.
- On electricity we wasted time, separating problems, writing them, instead of doing. I though we are going to tackle problems and clear up misunderstandings.
- The fact we had ice at night was repulsive on the side of cookers. We should have it during the day
- The diversity of experience and knowledge amongst members of the course.
- The way some of us behaved.
- Cutting paper and arranging them.
- Room very cold; you can't hear well whenever you feel cold.
- Not enough time for discussion.
- Other way to arrange transport.
- Time for application was short, we were left with doubts as to whether the strategies were applicable.

- I was expecting to be shown different approaches to problems. We were taught nothing about this. All things like stategies came from us.
- More sections of syllabus to cover.
- Classifying problems according to difficulty.
- I appeal for extension of time.
- None - since most of what we did was enjoyable.
- Extend for a whole week to have time to cover four topics.
- Limit suggestions by people who do not attend the lessons.

Response excerpts to the question: *Was it successful?*

- It was successful because we got different ideas.
- Gained techniques, have confidence in flow chart. I like yellow book which shows form of the exam in 1989.
- In chemistry it was successful but the problem is with electricity.
  Please give us chance doing some of the problems that appear to be a bit difficult, because some of us do not even know how to solve them even in the class.
- Yes, but the pamphlets must also have the solutions, because it may happen that I encounter a problem I cannot solve myself.
- There is more to be done.
- We learned to solve problems.
- Hope pupils will eliminate problems.
- It will be easier to solve problems.
- Yes, but these skills have to be refined, until they are short enough to be used in the exam situation, where time and full understanding of a concept are important.
- I think this should go forever, so that all teachers can be helped.
- It will work well if used, mainly if pupils can be included in framing questions like teachers did.
- More courses like this should be held.
- In a way, but time was short to implement strategies.
- Very, but little section of syllabus was covered.
- Yes, since teachers were very cooperative.
- In a certain way, yes, I still believe that if one gives pupils well organised knowledge on a particular topic, that will help them to understand, and if one understands something, he will be able to answer all questions under than topic.
- Now I am confident enough to face the exam papers with my pupils.
- Unsuccessful.
- Specially in teaching problem solving.
- There are so many things we take for granted. The course taught us never to take anything granted.

Response exercpts to question: *What would you like to do?*

Special study topics mentioned: Chemistry standard 9 and 10, static electricity, equilibrium, light, organic and inorganic chemistry, redox reactions, experiments pertaining to vectors, gases, waves, Boyle's law, oxidation, vectors.

General approach: Practical work, problem-solving experiments, discussion, more video tapes, exam questions, theory, practical work and experiments about the same topic.

Methods of instruction: Methods how to teach, demonstration lesson, how can we teach a certain topic, categorise problems according to level of difficulty.

Organisation: Specify the division of time between lectures and discussions, teach more topics than we had, more focus on matric topics.

Mutual help: Time should be allocated for helping each other in different aspects and problems.

- Invite moderator and examiner.
- Compile worksheets for practical work.
- Let us solve problems from previous papers on the board so that we can learn how other people solve problems that I fail to solve.
- We would like the course to be organised such that we say the topics and where we got the problems and the experiments are done, because in most cases, we do not have chances of doing experiments because of the lack of apparatus.
- I would like to do experiments, especially those which are examinable. Some of our laboratories do not have equipment so I would suggest that people give us alternatives so that experiments are not left undone because of the shortage of equipment.
- Since this has been a quite successful course in regard of problem solving, I feel there should be another course whereby the teachers will make more free charts for problem solving. It can be on the current year or next year on July when teachers will be on holidays. They will have covered the lot in syllabus, hence they will be able to make problem solving charts. More especially to those chapters that are examinable at the end of the year.

Laboratory Development Project

T. O'Neill & P. Hobden

Introduction

The laboratory development Project (LDP) focuses on the organisation and management of school science facilities and apparatus for carrying out practical work. The aim of the project was to increase the number of practical activities carried out in the science curricula of fifteen high schools. This project was jointly initiated in April 1988 by the Shell Science Centre and the physical science subject advisory service of the department of education responsible for the schools in question.

It was felt by both parties that the very poor science results being produced by these schools might improve if the amount of practical work (investigations, demonstrations, experiments, projects etc.) being included in the curriculum were increased. It was felt that this could be achieved if the resources available in the schools were more effectively organised, managed, and utilised.

Although provision was made in the syllabus for practical activities, there was little evidence that they were actually occurring. Observations were that in many schools the resources which did exist (equipment, glassware, and chemicals), although limited, were not being used at all. There was also equipment which was in need of only minor repairs but which had been left aside indefinitely. It was also felt that teachers were not highly motivated to do practical work and that laboratories/science teaching areas which did exist in some schools were being under-utilised or were not being used for science. These factors were seen as barriers to the effective use of practical work.

Since there was no mechanism available to directly address these problems, it was decided that the joint project be set up, with the department of education seconding a teacher to the project, which would be based at and otherwise funded by the Shell Science Centre.

The assignments of the seconded person would be formalised as the relatively uncharted work area dictated, but would probably include repair of broken equipment; removal of obsolete or irreparable equipment; demonstrating correct use of unfamiliar apparatus; transfer of surplus or redundant equipment to other schools; encouraging the improvisation of resources; improving the system of equipment and chemical ordering; devising and encouraging systems of stock-taking and stock maintenance in school science rooms.

Thula High School

With the aim of informing the reader about the characteristics of the school environment within which this project was carried out, details about the interaction with a single school will be presented here. The school name, location name, and teacher names have been changed. However, it must be emphasised that this is a real school rather than an abstraction or generalisation of the features of several. Hence neither the problems nor the strengths of this school can be taken as being completely interchangeable with those of other schools. Nor will all the problems or strengths of other schools be described here.

It may also be useful to note that if it were reliably possible to make some kind of *subjective* "ranking" of the project schools in terms of the areas of present concern, it would almost certainly be claimed that this school was currently one of the top schools.

Thula High School is situated deep inside a vast and densely populated expanse of semi-formal and shack dwellings in a suburb of Durban. There are few homes with electricity or running water in the area. And the everyday lives of the million-odd inhabitants seem to be continually plagued by violence of both criminal and political origins. The competition for the insufficient facilities, such as space, in Thula High School and the few other high schools is often fierce.

This background is mentioned here as it will be accepted that it is difficult to view a school such as Thula intelligently without having a knowledge of the community which the school attempts to be a part of.

For example, the power of a teacher is to interest his children in his subject, or to create excitement about practical work, must surely be affected if his students are in fear of attack while in the classroom or are sleeping in the veld at night for fear of attack in their homes. Or when peers die violently, as was to happen during the year with Thula High School, the disruptions which follow events such as these affect all aspects of school life.

Expectations before the first visit to Thula High School

From discussions with many teachers at in-service courses etc. the impression gained was that most school science departments were suffering from a lack of equipment and chemicals. Most teachers complained that this was a major stumbling-block. Most teachers, when pressed, would lay the blame for the problems with their science practical work (or absence of it) on the education department. Most department officials commenting on the laboratory problems tended in turn to lay the blame whole-heartedly on the teachers.

The First Visit

Thula High School was one of the first schools that was visited. In keeping with the initially stated aim of conveying a sense of the course of the project, a first-person account of the implementor's impressions and observations during the first visit are presented here with brief comment.

"Following the directions given by a departmental official (who had described the school as being "deep within enemy territory"), I eventually located Thula High School.

The school itself at first somehow impressed me as being large and spacious. But I soon noticed that there were no play areas nor any extra space at all. Perhaps the illusion of space had been created by the shacks which clustered so closely to the large barbed-wire perimeter, making the few metres of open ground inside seem expansive. The buildings were long, single-storey red-brick rows of classrooms (typical, apparently, of the style of school buildings built in the early eighties by the department responsible).

I met the principal, whose approval for the involvement of the school in the project had already been secured, and again outlined to him what it would entail. (It had been considered important that it be very clear to principals that there was no sense in which project implementors were either obliged or entitled to make any reports to them on the work of teachers; that the implementors's brief was to work directly with the relevant teachers; that the implementor's only duty was directly to the teacher, and never to be involved in or be seen to be involved in control, evaluation, or reporting.)

There is one point which is worth mentioning here, as it is a point that can be extended to nearly all the principals whose schools were subsequently visited. The principal of Thula High School required no convincing at all that it was proper that he shouldn't get reports. This was surprising in the context of a system which has always placed a high value on control, and hierarchical reporting. It was therefore more worrying than reassuring. In fact, it later became more evident that many principals did indeed have a very different attitude to their science subjects than to other subjects. It often seems that principals don't really want to know much about what's happening in the science department anyway. The attitude in some cases seems to be that science is a "difficult" subject in which the principal himself is not qualified. Hence it's better for him to keep his nose out of the science department (even if examinations and test results are worrying him) and leave the "experts" (science teachers) to get on with the job.

The principal took me to meet Talti, the physical science teacher, and said he'd be in his office if we needed anything. Talti was a teacher whom, as it turned out, I had met previously on an inservice course. I knew that he was a B.Sc. graduate (S.T.D. diplomas conferred by colleges of education are the more common qualification amongst the group of teacher with which I work)). Though teachers had already been officially informed of the project, I felt it was important again to outline the objectives, solicit his views on the merits or otherwise of the entire scheme, and again emphasise the points which had been made clear to the principal.

In short, I told him (truthfully) that there was no level at which anything that I saw in any school would be reported to the department authorities and that at any time he was welcome to tell me to leave. I would leave the school and would only revisit if he or another science teacher specifically requested contact. I felt it was vitally important to make this clear, as it was on this basis primarily that our hopes of developing a useful, supportive, two-way relationship depended. Were this position not accepted as bona fide, it was felt that the project might be condemned in the minds of teachers before it even began.

Talti responded that any help, almost regardless of what form it would take, would be welcome. From our conversation I gained the impression that there was a major service one could offer in simply providing channels of communication between himself, the department, and the service agencies (such as the Shell Science Centre). I picked up a feeling of tremendous frustration and a sense of isolation. (It's commonly complained that teachers are not permitted to phone the department regional office; that often responses to letters to the department are not forthcoming; that the principals have little time or expertise to help science teachers; that subject advisers are so stretched that they only get to most schools once or twice a year, and then that they are sometimes

so burdened with filing evaluation forms and checking management files that even they don't have much time to listen, empathise or address the "real science-related problems".

We then went to take a look at the science room. The layout consisted of "work-stations" at the sides and four island benches around which tables could be arranged. Although it was relatively recently constructed, the "lab" had no gas taps. The storage facilities were also inadequate (or would have been had there been any equipment more than the handful of items which were there) - there was only one small storeroom/preparation-room. And this was the only science room for the entire school (of about 800 children) for all the science subjects.

The most cluttered section of the implementor's memo for this first visit is the section titled "Teacher's view of the problems etc..." (see exhibit 1). It was felt that on the first contact with teachers it would be wise to concentrate on getting into discussion of obstacles (etc.) to conducting practical work in science lessons. It had been anticipated that while some of these would be very thorny physical problems which it would be difficult to work around, some might also be less serious ones, more in the nature of the excuses which one often uses for not venturing into unfamiliar areas. Both of these categories of obstacles, it was felt, could only benefit from airing.

Talti and I discussed each of the points that he had brought up. The biology teacher was also present. Talti was very open about the fact that he had managed to cover very little of the practical work prescribed in the syllabus. (It was later discovered that among all of the target schools there was only one teacher who had carried out any significant amount of the prescribed practical work. But not all teachers were so inclined to be open about the problem. With most it would only become obvious as one looked at derelict equipment or as the teacher was asked about particular "experiments". Very few were open enough to say that they had done no practical work with their pupils, giving reasons such as that it wasn't a priority with the syllabus being so long, or it wasn't the teacher's responsibility since the department was supposed to provide the equipment and it hadn't.)

The teachers seemed happy that we draw up a joint programme of action. We agreed on some tasks:

- The biology teacher and Talti together should draw up a lab timetable which allocated at least a few periods per week for senior biology classes in the science room.
- I would secure a loan of an overhead projector from the Shell Science Centre.
- Talti would phone me whenever he needed equipment or chemicals for a particular practical.
- I would ensure that I responded very quickly to such requests, even if it meant changing my itinerary. I would try to borrow such equipment as it was required (from other schools or from the Centre) and get chemicals in sample quantities from the University chemistry department, as necessary, until the department completed deliveries of stock which had been requisitioned two years ago.
- Talti would provide a motivation for the purchase of some bottled gas and regulators out of school funds. (Incidentally, this also was supposed to have been provided by the department. However, action was required in the interim.)
- I undertook to sort out some problems that existed with that year's requisition.
- I undertook to inform Talti of the dates of all upcoming inservice (weekend) workshops run by the Shell Science Centre. (He had a problem with not receiving communications mailed to the school - again, unfortunately, typical.)

I undertook to facilitate liaison between Talti and the head of science at another school which is quite close by, and which had more equipment.

Teachers agreed to go ahead immediately with ordering stock from the rather cumbersome requisition book, despite their feeling, based on previous experience, that it was a waste of time. I assured them that I was in a position to personally follow-up on all requisitions this year and that I wanted to do so. I realised that Talti and the biology teacher looked at me with a certain degree of, perhaps, polite scepticism. They had apparently been given plenty of undertakings by others. I was aware that if I was to build up any relationship of trust, I would have to be sure only to make undertakings on which I was confident that there was a good chance I could deliver."

Subsequent Developments

After that first visit, a friendly and productive relationship developed between the LDP and Thula High School. Talti became one of the few teachers who started regularly phoning the Centre whenever there was something he felt we could assist with.

All the undertakings given in the first visit were attended to. The only difficulty was the matter of requisition of stock. Although the teachers did not comply with the appeal that they give the system another try, the LDP largely failed in it's aims of expediting the process. (Eleven months after teachers had placed their orders, a survey con-

ducted by the LDP showed that more than 90% of the ordered materials had not yet been delivered to the schools.) It turned out to be a more difficult issue than had been anticipated, and it is an issue which the LDP is still giving much attention to.

Thula High School was formally visited six times during the subsequent year, but was also briefly attended to on other occasions en route to other schools. It's not necessary to detail all of these visits. But the events of another visit almost a year later will briefly be introduced. The general observation can be made that during the course of the year the nature of the support requested at Thula High School changed from the fundamental area of how to actually perform particular practicals to the business of procuring chemicals and equipment loans on behalf of the teacher.

During a return visit (see exhibit 2) I delivered an overhead projector, as requested, on loan from the Shell Science Centre. A copy of the "Lab Stock Book", produced by the project and also previously requested, was delivered and explained to Talti. Talti was preparing to teach the standard 9 inorganic chemistry section before other non-examinable sections of the syllabus in the event of disturbances later in the year. This section has a considerable practical component and consequently he was in urgent need of a number of chemicals. I took a list of the necessary chemicals. I removed an electroscope that required re-leafing. During school break I drove with Talti to the nearby school to show him the facilities which were available there (not much better, but different) with the hope of encouraging a sharing of limited resources and of expertise.

Disappointment

Progress in 1988 had seemed quite good. The teacher had become very involved with the INSET workshops coordinated by the Centre. He

Lab Development Project

SCHOOL.....
TEACHER .....

DATE **18-05-88**

TEACHER'S VIEWS OF MAIN PROBLEMS FACING HIM/HER W.R.T. EQUIPMENT, EXPERIMENTS AND THE LABORATORY:-

Has done virtually no practical work as he has virtually no 9/10 equipment. (Only have up to Std.8 - S.E.P. kit)

Needs an O.H.P.

Conflicting needs for lab between Biology, General Science & Physical Science.

Teacher doesn't receive mail

"Lab" quite new but no gas taps - Department of "Development Aid" were supposed to come back two years ago to finish!

OBSERVATIONS:-

Acid bottles with bad lables arrived from Protea this year (same as with Nkosibom.)

Requisition book is missing essential pages (eg page with ticker-timers)

There IS a need for an O.H.P.

Teacher maintains departmental stock-book.

Has received incorrectly invoiced equipment (Rutland)

There is some faulty equipment (eg. ammeters)

There is a spare toy-motor, turbine, hooter/flashlight.

REPORT:-

Discussed the ordering of equipment procedure with both Physical Science and Biology teachers.

Suggested a lab-timetable system.

Repaired an ammeter

Left index for departmental requisition book and copy of esential Std. 9 equipment.

Spoke to principal re. freeing some school funds for purchase of torch-cells, spirits and gaz-burners.

Promised to deliver immediately (from University stores) at least sample quantities of chemicals that were urgently needed.

ON THE NEXT VISIT:-

- ❑ New requisition book P.112, P.59, P.111.
- ❑ Shell Science papers on various matric topics (if any)?
- ❑ O.H.P. loan
- ❑ Video dubbing
- ❑ Follow-up on Rutland invoice
- ❑ Follow up on Protea acids.

Exhibit 1: Implementors memorandum: The first visit.

had covered a considerable amount of practical work and was well ahead of schedule with his syllabuses. The prospects for an excellent performance from his matric class had seemed high. However, during August the conflict, referred to earlier, in the area surrounding Thula High School suddenly escalated beyond all previous levels. The school quickly ground down to a near standstill.

The result for the school science department was that the teacher felt that the understanding which had been building up between him and his students concerning the value of practical work was damaged; the need for a more compact remedial programme (concentrating on the backlog of theory to the exclusion of practical work) became the envisaged schedule for whenever (if ever) the students returned.

As it turned out, there was no real return to classes after August. And inevitably the final exam results suffered. Less than half the science class passed.

The Next Year

1989 began, and progressed, shakily for Thula High School. A sufficient number of students returned to school to allow some teaching to resume. As may be established from the second account given above (see exhibit 2) of a visit to Thula High School in 1989, the teacher was proceeding with his teaching and practical work programme regardless of setbacks.

In March 1989 the department announced a list of 64 practicals for standards 9 and 10 physical science students, which candidates would need to be familiar with to answer many of the examination questions in the senior certificate examinations that very year.

This unavoidably affected the focus of the LDP. No matter what other ideas there had been, the first priority now was to see to it that senior physical science students were at least observing these examinable practicals. In consultation with the teacher from Thula High School and a few other teachers a programme was drawn up which linked these practicals with the work schedule.

Lab Development Project

SCHOOL.....
TEACHER.....

DATE **20-02-89**

REPORT:-

Discussed proposal re. teaching inorganic chemistry before non-examinable sections of Std.9 syllabus, especially with respect to the list of chemicals he would be short of for this.

Drew up a list of such chemicals.

Delivered S.S.C. O.H.P. on loan (same as last years arrangement - i.e. science use only)

Delivered L.D.P. stock-book (as requested).

Removed electroscope for 're-leafing'.

During break-time, drove with Mr M. to meet Mr Z. at a neighbouring school. We showed Mr M. the facilities and stock which is available there so that he knows what assistance he can call on from that school. Suggested that Mr Z. pay the reciprocal visit soon (however he seems to be the one who is not very interested in developing this partnership.)

TEACHERS VIEWS OF MAIN PROBLEMS FACING HIM/HER W.R.T. EQUIPMENT, EXPERIMENTS AND THE LABORATORY:-

Students are very behind with work (including practicals).

With present tension, students don't do homework or write up practicals.

He is organising Saturday lessons.

OBSERVATIONS:-

Return to shaky 'normality' (army trucks are no longer on grounds. But security police are occupying the staff-room, so teachers have to work elsewhere.)

Relationship between teacher and children is still very friendly and informal. Children are still very receptive and eager to participate.

Observed a practical lesson in progress.

ON THE NEXT VISIT:-

- ❑ Periodic Chart
- ❑ Chemicals (as per list)
- ❑ Conical flasks
- ❑ Check progress on chemical sorting.

Exhibit 2: Implementors memorandum: Nine months later

The plan which was subsequently followed closely by Talti (and to varying degrees by other LDP teachers) was to cover all the compulsory practicals as their respective sections were dealt with, and attempt during school vacations and weekend lessons to catch up on practical work on the topics that had already been covered. For the standard 10 classes this was quite a big undertaking for it meant, as well as recapping on the earlier topics of this year, going back to all the standard 9 topics in which practicals now prescribed had not been covered.

For the remainder of the year much LDP time was spent in simply attempting to meet the many requests for loans of equipment and chemicals. These requests also came from Thula High School and from other LDP schools. But they also came from other department schools not officially covered by the LDP, and it was decided that in all cases the project had to try to help. It must be pointed out that the LDP implementors appreciated that at best this was a hit-and-miss patching up process.

Progress

As previously mentioned, Talti has started visiting the Shell Science Centre quite often. He also changed from being a quiet, occasional attender of INSET workshops to being a prominent figure, conducting many of the workshop sessions. Talti continues to phone the Centre if he is in need of chemicals or some item of equipment. He often visits the Centre to borrow videos and other resources.

It now seems clear that, were the LDP disbanded and visits to the schools suspended, though it would make life a bit more difficult for Talti, it probably wouldn't make much difference to the quality of Talti's input in his science department. He is now well on the road of "personal professional development" and certainly not isolated. He would find a way to get whatever resources or advice that he needed.

What precise share the LDP had in stimulating Talti's evident professional development is of course uncertain. But the LDP can claim at least some of the credit.

Concern about the continuation

One important question is, what happens when Talti leaves? He may go this year or he may wait for another year. But he almost certainly will leave. There is an extremely high turnover rate of science teachers at schools. After the first year of the project, of 15 schools in the Durban/Pietermaritzburg area only 6 still had the same physical science teacher as when the project commenced. Talti aims to go back to university to do further study. (Other teachers transfer to other schools, transfer to other education departments, but more commonly, change to other teaching subjects, go to industry, or take up more senior posts, for example, deputy principal).

Since this project offers support to the teacher rather than to the school, this mobility of teachers poses a very real threat to the ability of the project to quickly reach a point where it can be said that the initial aims have now been largely satisfied, and that it is time for the project to progress to a more advanced stage in the process of improving science education in the school.

Conclusions

Achieving the original objectives of the LDP

By way of conclusion a brief review of the manner and extent of the LDP's development is given. This is done considering the project as a whole and also the originally stated assignments drawn for the seconded implementor.

The repair of faulty equipment has been undertaken at different levels, getting assistance from University physics department technicians where necessary.

One of the most prominent demands that the LDP has been required to address is to demonstrate to teachers the use of items of equipment which they do have in stock. Considerable assistance has been rendered in showing teachers the set-up of various of the compulsory practicals.

Although there are few schools with a complete set of apparatus or chemicals, there are some where these have been oversupplied. Usually however, it is the same item that is oversupplied from school to school, nullifying its transferability. There have, however, been cases where resources have been more valuably redistributed by the LDP.

Some improvisation of equipment and technique has been achieved. But this has occurred more at the LDP level than on individual school level. For example, cheaper and simpler ways of performing the inorganic component of the physical science work (than those recommended in textbooks) have been suggested by the LDP, and used by many of the LDP schools.

Both the points regarding improvement to stock requisition procedures and stock-taking procedures were looked at in considerable detail and the development of a comprehensive computerised system which would simplify and make efficient the processes at all levels was embarked

upon by the LDP. By the end of 1989 this system was being readied for its first stages of testing and by late 1990 had been piloted in a few schools.

During the course of its operation, the LDP also inadvertently became involved in an unanticipated and somewhat tangential area, not directly applying to any of the selected target schools. The LDP by virtue of its name attracted requests for guidance from a number of semi-private schools which had been promised funding from different sources for the building of a "laboratory", but who had little idea of what they would actually need or where to go for advice. The LDP has since accumulated considerable resources and documentation on this area and has been able to suggest science room or laboratory plans for a number of such schools.

The Future of the Lab Development Project

Most of those who have knowledge of the area of concern of the LDP will agree that it is certainly one which can only need more attention in the immediate future. However, whether the approach that the LDP has taken will always be accepted as the correct one to use up to this point, or whether it is seen to provide a useful model for future work in the area, cannot be predicted with certainty.

Furthermore, it is very difficult to predict at this stage how official education department thinking will develop with regard to the relatively new issue of secondments and other aspects of cooperative projects between state education structures and privately funded service organisations such as the Shell Science Centre. These are some of the factors which will determine the longer-term future of the LDP.

Educators involved in the LDP for their part would express the belief that their work has had an impact, even in these turbulent transitionary years, and that given the more stable educational environment which everyone must hope will soon be prevailing, the type of work which the LDP undertakes would have great positive effect.

INSET Programmes

BIOLOGY

A. Ziervogel

Introduction

This report is in three parts. The first gives the comments of the centre subject coordinator on the reasons for the introduction of a regular Biology INSET programme for local Durban teachers, the aims of the programme and what has been accomplished in the short period since the programme's inception.

In the second part an outside observer who attended the first workshop of the series comments on the group dynamics and interactions which took place. The observer also makes recommendations for the running of future programmes.

The third part contains the responses of teachers to an evaluation questionnaire on the fourth workshop and the INSET programme as a whole.

Rationale for Biology in-service courses

A. Ziervogel

Introduction

Until the beginning of 1990 biology INSET courses of 1-3 days duration had been run with groups of standard 10 teachers throughout Natal once or twice a year. These INSET courses were undertaken at the request of the biology subject adviser for the KwaZulu Department of Education and enabled one high school teacher from each school to participate and receive materials to take back to the school. However, this was regarded as unsatisfactory as human resources were being spread too thinly for much benefit to be felt.

The KwaZulu matriculation biology results are so poor that it was considered necessary to provide an intervention programme on a more regular basis. The suggested programme is based on the following reasons for the poor matriculation results:

- ☆ Many senior teachers are underqualified. Few have a degree in the biological sciences and some do not have a senior teacher's diploma. It is not uncommon to find teachers taking senior biology classes with a primary teacher's diploma or a senior diploma with a major in another subject area. As a result, many teachers lack confidence in teaching the subject.
- ☆ Few high school teachers keep up to date with new developments in biology.
- ☆ Few teachers do practical work with their pupils, despite the fact that this is examined in the final matriculation theory paper.
- ☆ Most teachers use the transmission type of teaching method, which does not encourage interaction between pupils or between teacher and pupils. Discussion of concepts and problem areas is not encouraged.
- ☆ Most teachers have poor testing skills. Tests and examinations focus on recall of knowledge only despite the fact that the final matriculation paper tests comprehension and application.
- ☆ Class sizes are large, facilities in the schools are inadequate, and teachers are not provided with skills to manage large groups effectively.
- ☆ There is a strong feeling of isolation. Teachers do not get together to share ideas, tests, or work loads. This reinforces the lack of confidence and helplessness.

It was decided to provide an intervention programme on a regular basis for local high school biology teachers. A similar programme has been offered for several years by the physical science and mathematics coordinators of the Centre.

Aims of the Programme

The aims of the programme are:

- ❑ To increase the subject knowledge of teachers and their confidence with the subject.
- ❑ To expose teachers to new teaching methods of pair and group work, group problem solving and cooperative learning. This is seen as an effective way of handling large classes and ensuring that active learning occurs. To learn science, students must not only adopt new ideas but also modify or abandon their pre-existing ones. In this process learners actively make sense of their world by constructing meaning. Students are seen as active learners who come to science lessons already holding ideas about natural phenomena.
- ❑ To expose teachers to practical work to build up their confidence in using apparatus and incorporating practical work into their theory lessons.
- ❑ To enable the teachers to develop to a point where they feel confident in taking charge of their own professional development as teachers.
- ❑ To effect a change of attitude from one of helplessness and of being trapped in an impossible system to one of confidence in possessing sound subject knowledge and methodologies for effectively coping with their teaching.

Results

This regular intervention programme started at the beginning of 1990. After three in-service sessions each of 3 days' duration, we are still a long way from achieving our aims.

A subject action committee consisting of one teacher from each of the five participating local circuits was elected by the teachers. This action committee meets before the in-service sessions to discuss teacher feedback and to plan the programme. The composition of the committee has changed as two members have dropped out and

been replaced. Usually only three of the five are present at a meeting.

The teachers have indicated a preference for an emphasis on subject content in their in-service programmes. One of the teachers may elect to lead a discussion on a particular topic or the centre coordinator does it. Watching videos on the topic is also enjoyed.

Problem solving using questions taken from past matriculation papers is valued and this allows pair and group work.

So far there has been little discussion of teaching method. Individual sessions have included construction of teaching aids, an activity enjoyed by some and ignored by others who prefer a chalk and talk style of teaching.

Some of the participating teachers are not keen to do the practical work associated with the subject.

As the sessions are conducted on a democratic basis, the participating teachers are free to participate in any of the planned activities, but suggestions made by the Centre subject coordinator are considered. Group and pair work in problem solving takes place and is seen as the means to changing teaching in the classroom. The preference for subject content will also be continued, but combined with discussion on how best to teach the topic.

An Overview of the First Day of the Shell Centre's Biology Workshop

E. Russell

The workshop was held in the Art Studio on level 3 of the Denis Shepstone Building on the Durban campus of the University of Natal.

The workshop on the first day (27 April 1990) lasted for 6 hours. One hour and ten minutes were used for the tea and luncheon break. Proceedings were scheduled to start at 8.30 a.m., but the late arrival of the transport ferrying attendants to the workshop resulted in a delay of 40 minutes. Members continued to drift in during the workshop.

The first day of the workshop was facilitated almost entirely by the Shell coordinator responsible for biology.

Much of the time of the workshop (2 hours) was taken up with the attending teachers engaged in "seat-work". The coordinator had set them the task of creating teaching models that they could use with their classes. This involved using pipecleaners (dyed different colours) and paper plates to construct models of chromosome configurations. The task seemed useful, but several of the teachers appeared uninterested and did not invest much effort in this aspect of the workshop. The majority did participate fully in the activity, though many were very slow.

Expository teaching took up almost 2 hours of the workshop time. The coordinator spent much of her time using the overhead projector and slide projector to work through slides and diagrams of the stages involved in meiosis and mitosis. She very frequently stopped and asked questions. These were directed to the whole gathering but were usually responded by the one articulate and fast action committee member present.

Discussion between the coordinator and members, and between the teachers themselves, occupied approximately half an hour during the first day of the workshop. Of the five discussions which developed, four occurred during the expository teaching. This can probably be attributed to the frequency with which the coordinator asked questions. These tended to stimulate debate. Showing of two video films took up 24 minutes, and much discussion followed. The coordinator was severely inconvenienced by a failure in the power supply.

The coordinator frequently discussed how concepts should be conveyed to the pupils. Many of her questions concerned the method of problem solving. The teachers appeared most concerned to keep abreast of new developments in knowledge in the fast-changing area of genetics.

The coordinator modelled effective teaching behaviour for the teachers. She asked many questions, and would not proceed until attendants had responded to the questions. She outlined what would be covered during the workshop, referred to the relevant literature, did not pretend to know things that she was unsure of but undertook to try to find out about questions she could not answer, and she encouraged attendants to respond to questions from their peers rather than always responding to them herself.

Summary

This was the first biology workshop held by the Shell Science Centre and no pattern of interaction between members had had a chance to solidify at the start of the workshop. Attendants did not know each other well and were initially reticent in their interaction. The emphasis on "seat-work" was one of the positive features of the workshop, but several of the participants did not seem to share the perception of the need to create the models to use in their classes. The biology action committee meeting preceding the workshops was not entirely satisfactory in that only one representative of the teachers had been present. It had therefore not been possible to achieve any broad consensus in planning for the workshop. It is important that the action committee meeting should be well attended.

The coordinator's frequent questioning of the group was commendable but they were largely responded to by one participant. He was invariably correct and his swift retorts had an inhibitory effect on the participation of others. In contrast the coordinator appeared a relaxed and sympathetic person. The teachers appeared relaxed in their interaction with her. She was approachable and supportive.

Biology Inset: Evaluation Comments

A. Ziervogel

A 2-day biology INSET course was held at the University of Natal on 21 and 22 August. This was the fourth in a series of five 2-day workshops planned for 1990. This particular course covered the use and interpretation of graphical data in biology, data response questions, homeostasis, and the endocrine system.

Questionnaires for evaluating past workshops have used questions requiring direct answers, for example "How useful did you find each of the following topics?" with a list of topics covered at the workshop following the question and available answers "of no use", "useful", and "very useful". The questionnaire administered on the 22 August was of a more open-ended type. Participants were asked to answer a one-page open-ended questionnaire containing three questions. No guidelines were given on answering the questions, but the space left below the question limited the length of response. Twenty-two participants, of which nine were female, completed the questionnaires. The responses are summarised below.

Results

Value of the course as a whole

All the participants reacted favourably to the question, but in different ways. Some felt the main value of the course was that it afforded a venue for teachers from different backgrounds to meet and share ideas and experiences. Others were more direct in their evaluation and felt that the course dealt with particular problem areas, such as the drawing of graphs and interpretation of data presented graphically (considered particularly relevant to those biology teachers who had not studied mathematics at school beyond standard 7), how to present topics such as homeostasis, and problem solving.

One activity which the participants found interesting and useful

The question was formulated as follows:

- ☆ Name one activity of the programme which you found interesting and useful.
- ☆ Describe the activity and explain why you found it interesting or useful.

Many of the teachers indicated that they had found group problem solving of questions from past matriculation examination papers and other materials useful and enjoyable particularly because it actively involved all of them.

The section on drawing of graphs was presented by the Centre's mathematics coordinator and was valued by teachers with little mathematical background. Current matriculation papers often present data in the form of tables and graphs for pupils to interpret and manipulate. Teachers with poor mathematical skills tend to avoid such questions, which means that their pupils are at a disadvantage. After the session on drawing graphs, all the teachers present felt more confident about tackling questions based on graphical data.

Several teacher indicated that they found the discussion on homeostasis useful as this section required pupils to draw together components from many different areas. Pupils (and teachers) find synthesis of knowledge from components difficult. Others enjoyed watching videos on this section of the syllabus as they had not been exposed to teaching aids before.

Things acquired on the course which will be of use in schools

The last question was formulated as follows:

- ☆ Can you name one or two things which you learned in this course and which you may use in your work in the future?

The responses indicated that the teachers felt far more confident about tackling open-ended questions. They worked on these in pairs during the workshop and it was emphasised that there is often more than one correct answer to this type of question. All responses were encouraged and treated equally. Teachers were asked to evaluate the accuracy of each other's responses to particular questions.

Implications for future INSET of information obtained from the questionnaire

Group problem solving reduces anxiety in the answering of open-ended questions and the interpretation of graphical or tabular data. This will be continued for two reasons: firstly, it will increase teachers' confidence in tackling problems and secondly encourage them to use pair and group work in class with their pupils. Exposure to different teaching aids which can be used in schools will be continued. This helps teachers to gain a more comprehensive picture of the topic and encourages them to use aids in their teaching. The Centre has video recorders, biology tapes, and models for loan to teachers.

INSET Programmes

MATHEMATICS

P. Ntenza

Introduction

During 1990 the mathematics project of the Shell Science and Mathematics Resource Centre organised three in-service education and training (INSET) courses, each one and a half days long. The courses were for senior secondary mathematics teachers in the greater Durban area and at five other field units of the network of the Centre, namely Ladysmith, Newcastle, Greytown, KwaMbonambi, and Port Shepstone. Two 5-day courses were also organised at Michaelhouse for teachers from thirteen circuits in KwaZulu.

The average attendance at each course was 55 in the Durban area, 65 at Michaelhouse, and between 15 and 25 at each of the field units.

The topics dealt with in these courses were linear programming, calculus, analytical geometry, trigonometric graphs, logarithmic functions and inequalities, proportionality, similarity, and the theorem of Pythagoras. Other aspects of mathematics that were included in some of the courses were an approach to the teaching of Euclidean geometry at senior secondary level, working investigatively in mathematics and expressing generality and algebraic thinking, how to set an examination/test question paper, and compiling a memorandum in mathematics.

This report presents some aspects of these courses: the rationale of the mathematics INSET courses; a detailed description of activities in one particular INSET event in the Durban area in an attempt to examine INSET activities in the light of the principles specified in the rationale of the mathematics INSET programme; a summary of INSET activities in Durban during 1990; and examples of handouts given to the participants of the course. The article summarises the reactions of participants to an INSET event as conveyed by an external evaluator in interviews with participants of one of the courses.

Rationale for Mathematics INSET Course

P. Ntenza

Two main areas have been identified by the project coordinator in conjunction with the mathematics action committee as being crucial to running the INSET programme, namely:

- Discussing (innovative) teaching methods in particular topics in mathematics.
- providing participants with more content knowledge especially in the sections that have just been added to the mathematics syllabus (first examination: 1989). This section contains topics like calculus, linear programming and analytical geometry.

In the medium term it is hoped that there will be an improvement in the mathematics achievement level of those students taught by participants in the course. Certain principles or guidelines will need to be kept in mind by the organisers of any mathematics INSET workshop. Teachers should be aware that some topics can be taught as a mental exercise, devoid of any practical value, and others in a way that helps students to use mathematics in dealing with problems of a practical nature. Exercises of the latter type are preferable to those of the former type.

Another important principle is to deal in the INSET workshop with teaching methods as well as knowledge content, even if the topic in question is a new one. It will not be useful for participants to acquire knowledge but find that they cannot transmit this knowledge using appropriate teaching methods.

When determining future INSET topics, organisers (and participants) also need to attempt to find answers to some of the following important questions: Why teach mathematics at all? Why do some children not experience success in the study of mathematics? Why do most students take mathematics? Is the learning of mathematics different from the learning of other subjects? What are the applications of mathematics in real life?

If a typical answer to the second question appears to be that "Children lack basics", this could give rise to a certain amount of time being given in an INSET workshop for teachers to discuss how the problem may be remedied in the classroom.

In the short term one of the aims of the mathematics INSET programme is the provision of support, facilities, and much-needed resources to standard 9 and 10 mathematics teachers. Specialist INSET courses will also be provided as needed, for example when changes or additions are made to the syllabus. It is also important to emphasise methodology more than content in any particular workshop, although when dealing with altogether new topics it could be the other way round. Since most teachers teach large classes, they need to equip themselves with better teaching strategies and techniques, combined with technological innovations (where possible), to handle such classes. These teachers need help in generating their own resources such as worksheets and charts. Another important principle for achieving short-term goals is to teach INSET participants to a higher level (especially in calculus) than matriculation requirements. Even college syllabuses do not cover more ground than the matriculation syllabus and most teachers graduating from college find themselves teaching up to matriculation level.

In the long term our goal is to produce competent mathematics teachers who will be professionals in their own right; our interaction with them (at least twice a year) in one-and-a-half-day programmes is of much value in enabling us to achieve this end. It is also hoped that the INSET model used by the Centre will be taken up by the responsible authorities and other independent groups as we believe it is working very well for us.

Description of INSET workshop no. 3:

27 - 29 July 1990

P. Ntenza

Attendance.

There were 51 standard 9 and 10 mathematics teachers in this workshop, the lowest attendance compared with two other workshops held in March and May, with attendance of 55 and 60 respectively. We had invited 60 teachers to attend the course.

Facilities.

One of the hotels in Durban was used for the workshop. Accommodation, catering and conference facilities were up to standard and excellent.

The Programme

The action committee had planned for the topics: linear programming and applications of calculus to be covered in two and a half days. The programme commenced on Friday at 9.30 a.m. with registration. Linear programming was dealt with from 10.00 a.m. to 5.30 p.m. on Friday and from 8.30 a.m. to 1.00 p.m. on Saturday. The section on applications of calculus was covered through discussion and problem solving from 2.00 p.m. to 5.30 p.m. on Saturday and from 8.30 a.m. to 1.00 p.m. on Sunday. There was a one-hour lunch break and two 30-minute tea breaks on each day of the programme. The programme took place very much as planned.

Handouts

Pamphlets on the following were supplied to the course participants:

- ☆ Linear programming: systems of linear inequalities in two variables; obtaining the feasible region, and optimisation (44 pages).
- ☆ Curve sketching: 40 third degree polynomials (2 pages).
- ☆ Simple practical problems involving maxima and minima, and rates of change (4 pages).
- ☆ Typical matriculation examination questions: calculus, remainder and factor theorem, linear programming, and analytical geometry (27 pages).
- ☆ "How about some third degree?": an article (*Spectrum*, February 1988) showing a method of making up a cubic function which not only has rational intercepts on the axes, but also has turning points which have rational coordinates.

Types of Instruction

Theoretical background was given in lectures. Problem solving and approaches to teaching problems were dealt with and individual instruction was given in a number of cases. Tutors had been advised beforehand to do more group work and have different groups report back on different types of exercises. This allowed discussion by participants and tutors on the various methods used by the groups in solving each type of problem.

The division of lecturing and group work occurred as follows, taking *curve sketching* as an example: the tutor covered the theoretical background for sketching third degree polynomials. Important aspects were covered such as finding the critical points; using the first derivative test; using the remainder and factor theorem to obtain the zeros; points of inflection and recognising these; and using the second derivative test, which is more efficient and quicker than the cumbersome first derivative test, but unfortunately not in the matriculation syllabus.

Approximately one hour was spent on the lecturing. To apply theory to practice, the tutor then selected a third degree polynomial, and together with participants various computations were made leading to the drawing of a rough sketch of a third degree polynomial. Further explanations and clarifications were made where necessary. Participants' questions were answered by tutors and participants themselves. Participants were then divided into five groups, each group spending about 45 minutes on two or three exercises that differed from those assigned to the other groups. The approach to teaching and solving problems in the classroom was emphasised. Each group appointed a spokesperson who, using either an overhead projector or flipchart, would show all participants the method used in finding the solutions and the recommended approach to teaching that part of the topic. Other participants could then be given a chance to criticise the report-back, which was made up to a maximum of 10 minutes for each group.

The rationale as reflected in the course

Advanced (or new) subject content:
The second derivative test, which is not in the matriculation syllabus, was easier to apply than the first derivative test from the participants' point of view. Nevertheless participants were made aware that pupils had to be taught how to use the first derivative test, faster pupils being taught the second derivative test as enrichment.

It was also discovered that some exercises on maxima and minima from a matriculation mathematics textbook *might* require the use of "further differentiation", which involves the composite function rule, the product rule, or even implicit differentiation, aspects which are not included in the present matriculation syllabus. This is an example of such a problem:

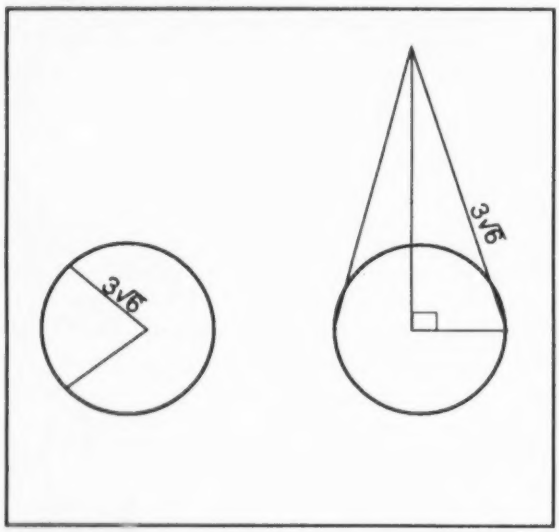


Figure 1

A cone is to be formed out of a circular piece of cardboard by cutting out a sector and sticking the two straight edges together. If the radius of the circle is 3√6, show that the cone of maximum volume so formed has a base radius of 6. (Hint: vol. of cone = 1/3 base area x height; work with $(\text{vol.})^2$).

To handle such exercises, participants needed to be taught to use either the composite function rule or the product rule.

Dealing with content and method:
As shown above in discussing groupwork, the course covered methods and approaches to teaching the subject in class as well as content.

Practical Value:
Most exercises, especially in the linear programming handout, contained problems of a practical nature requiring one to find the best solution. In some cases participants had to decide whether solutions had practical value. For example, let us consider the following problem which appears in the given handout:

One kind of cake requires 200 g of flour and 50 g of fat, and another kind of cake requires 100 g of flour and 50 g of fat. Suppose we want to make as many cakes as possible but we have only 4 kg of flour and 1,2 kg of fat available. How many cakes of each kind should we make?

The solution to this problem is that there should be 10 2/3 cakes of one kind and 21 1/3 of the other. Participants raised the possibility of baking 2/3 or 1/3 of a cake, but in practice one can only bake a *whole* cake which can then be cut so that you have 2/3 or 1/3 of it!

Developing resources:
Although this particular rationale was not directly applied in the course, some participants pointed out the need to be able to create for themselves third degree polynomials which had both rational critical points and rational zeros, as most of those in mathematics textbooks having very awkward critical points or zeros made them difficult to plot on the Cartesian plane. Participants were given a rather difficult article presenting a method for obtaining rational critical points and rational zeros, although tutors did not elaborate on the method shown.

Psychology of learning mathematics:
This was not discussed in the workshop.

Interest of participants.
Participants showed interest and participated in discussions in a lively manner throughout the workshop. They seemed eager to learn and generally contributed to making the workshop a success.

Critical review of events

The overall impression gained from evaluation forms filled in by participants at the end of the course was that the workshop was successful in terms of satisfying teachers' needs. Although attendance was slightly less than expected, the group was large and interesting to work with. I believe it is necessary to give teachers more content subject knowledge than is otherwise required by the matriculation syllabus. Included in the course were the second derivative test, the composite function rule, the product rule, and the quotient rule. These aspects are not included in the matriculation syllabus, but familiarity with them is of importance to teachers especially when syllabus changes are made and certain sections are added or extended to cover more in-depth work at an advanced level.

Summary of INSET activities in mathematics, 1990

P. Ntenza

Attendance figures in the mathematics INSET groups have been relatively high (between 50 and 60) in the past three INSET workshops for the Durban area. This could be attributed to the fact that teachers find the workshops valuable, well-organised, and interesting, also taking into account the inducement of providing accommodation in a hotel.

In the first workshop the Department of Education and Training chief examiner for the mathematics SG first paper provided teachers with information and tips right at the beginning of the year which they could put to good effect in their classes. In the second workshop local senior secondary school teachers led discussions on two topics in mathematics, namely trigonometric graphs and logarithmic functions and inequalities. Various classroom methods were discussed and exercises/problems were done with an emphasis on the approach to teaching particular aspects of the topic. Interesting arguments evolved among the teachers, and although tutors did not have any previous experience in teaching adults, with the help of the project coordinator they were able to handle their sessions fairly well.

The first and third programmes occurred as planned by the action committee. At the second workshop, after letters of invitation had been posted to teachers, there was an industrial strike by workers at the hotel booked for the purpose. The project coordinator, after consultation with the chairman of the action committee, had to switch the venue to a more expensive hotel as other hotels were fully booked, and consequently the programme had to be reduced from the planned two and a half days to one and a half days.

Participants were notified of the changes. Some got the letters in time and others did not; the latter were redirected from the first venue by the project coordinator, but the programme commenced one hour later than planned. Furthermore, no one had checked the conference facilities of the hotel, and it turned out that the conference room was rather narrow and too small to hold the 60 teachers who attended this particular workshop. In spite of all this, participants somehow seemed to enjoy the workshop and everyone was able to manage the situation quite well.

A lesson learnt is that any venue for a course needs to be visited and appraised for suitability by the project coordinator. There should be enough room for group work, a classroom-style setting of tables and chairs, and a clear view of equipment (such as the OHP screen) from all parts of the room by participants.

At times it happens that a tutor proposed by the action committee in its planning meeting is not available because of other commitments. In such cases the action committee has given the project coordinator the mandate in selecting any other suitable person to do the tutoring.

Handouts

This section contains some excerpts from handouts distributed to course participants. Handouts are widely used teaching aids in the INSET courses as well as in other instructional frameworks. In the mathematics INSET programme they are of special importance for the following reasons:

- They help in the teaching of the course as tutors do not have to write down everything they teach and participants are relieved of the task of taking notes. Participants are more likely to listen critically to the tutors and hence initiate discussions.
- Participants can review the content of the course and discuss details with peers. Input of participants into the content of the course is of great importance to tutors and developers of the course.
- Participants can collect resource materials for use in teaching mathematics in their classes.
- Mathematics textbooks do not contain the "new" or advanced material which we sometimes present to course participants. Also, most textbooks do not have a wide enough variety of problems in their exercises and thus the handouts could be used as supplementary material.

Three types of problem are represented in the following samples: new material, practical value of mathematics and the psychology of teaching mathematics.

New material

❑ Harder derivatives from first principles

Limits of the type:

$$\lim_{h \to 0} \frac{f(x+h) - f(x)}{h}$$

where f(x) is of the form:

(i) $f(x) = x^{3/5}$

(ii) $f(x) = x^{-7/8}$

(iii) $f(x) = x^{49}$

❑ Application of calculus

(i) Problems on maxima and minima - theory on these to include the second derivative test, concavity, and points of inflection.

(ii) The composite function rule

Actual problems on the above aspects have been indicated above in the descriptive report in dealing with "the principles of the rationale" as revealed in the course.

❑ Linear programming

The simplex method for a special problem.

Example: Use the simplex method to solve the following problem:

The Cubans have two types of ballistic missiles: type 1 (New York range) weighs 12 tons, type 2 (Washington DC range) weighs 10 tons. They have an inventory of ten of type 1 and six of type 2, some of which are to be shipped back to Russia via two (Czech) destroyers. The volume of the missiles poses no problem, but ship C has a weight capacity of 100 tons, and ship D a weight capacity of 60 tons. If the Czechs charge the Cubans $600 per ton for material on ship D and $500 per ton on ship C, how should they load their ships to capitalise on the plight of the unfortunate Cubans?

Practical value

❑ Linear programming

Example: Dr Gonondo, the eminent traditional healer, claims he can cure AIDS with his revolutionary 3 - layer khubalos. There are two kinds of khubalos, the chatha khubalo and the phalaza khubalo. Each khubalo consists of grains of aspirin, bicarbonate, and codein. Now, Dr Gonondo's forefathers have revealed that it requires at least 23 grains of aspirin, 97 grains of bicarbonate, and 29 grains of codein to effect his remarkable cure. The number of grams per grain of these khubalos is as follows:

Khubalo	Aspirin	Bicarbonate	Codein
Chatha	2	7	11
Phalaza	3	5	8

He now wants to know how much of each khubalo to prescribe in order to *minimise* the total mass. Formulate, without solving, a linear programming problem that will solve his dilemma.

❑ Maxima and minima

Example: Out of a piece of sheet metal 24 cm by 24 cm you want to make a pan to hold the maximum volume of fudge. To do this you cut the corners as shown then fold along the dotted lines, and weld. How much must you fold to get maximum volume? What is the maximum volume?

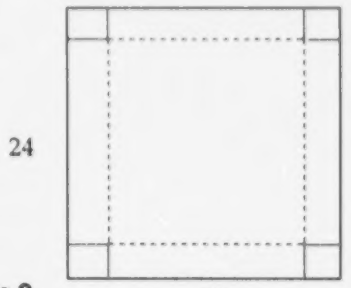


Figure 2

The psychology of teaching mathematics

Example of excerpt from handout: Bloom's taxonomy of cognitive learning applied to mathematics. Cognitive learning is divided into six categories, namely,

1. Knowledge
2. Comprehension
3. Application
4. Synthesis
5. Analysis
6. Evaluation

For mathematics purposes we regroup into

1. Knowledge & skills
2. Comprehension
3. Application
4. Creative thinking (higher order thinking - which is 4,5, and 6 in above categories)

The ideal categorisation for a standard grade question paper centres on

Knowledge	5%
Skills	40%
Comprehension	25%
Application	25%
Creative thinking	5%

This means that pupils who know all their formulae and manipulations can easily obtain 45% in an exam.

Illustrating the above from the syllabus:

1. **Knowledge** if $f(x) = nx^3 + bx^2 + cx + d$, then the remainder can be obtained without division when dividing by x - a, and if $f(a) = n(a)^3 + b(a)^2 + c(a) + d = 0$ (meaning no remainder) then x - a is a factor.

   Skills Factoring third degree expressions.

   Application Graphs - finding intercepts and critical points.

2. **Knowledge** **All exponent laws**

   $a^m \times a^n = a^{m+n}$, etc.

   Skills Simple exponent problems.

   Comprehension and application Exponential equations, problems with surds, rationalising the denominator.

3. Knowledge Meaning of $\lim \frac{f(x+h) - f(x)}{h - 0}$

   Rules of differentiation:

   $D_x(x^n) = nx^{n-1}$, etc.

   Skills Differentiating simple expressions.

   Application Finding the gradient at a certain point.

   Creative thinking Finding the height of a projectile or maximum volume of a solid, etc.

Interviews with Teachers Attending Mathematics Workshops

E. Russell

Background

Three mathematics teachers attending a 2-day mathematics workshop were interviewed using a structured questionnaire containing open-ended explorative-type questions.

The workshop was held at a comfortable tourist class hotel on the Durban beachfront. Respondents were chosen by numbering the participants at the workshop and selecting the 3rd, 4th, 5th, and 6th person respectively from rows 1, 2, 3, and 4 in the conference room used as a venue. The person selected from row 4 declined to be interviewed, pleading a prior engagement.

The teachers selected were requested to remain in the conference room at the end of the workshop. They were then interviewed individually. All respondents taught mathematics to standard 10 pupils at "black" schools. One respondent worked at a school located in a rural area, which the other two at schools located in urban-peri-urban areas.

Findings

Two of the respondents had attended most of the Shell Science Centre's mathematics INSET workshops since 1988. One of the respondents had only attended one previous mathematics workshop. All had been advised of the workshops by their principal or head of mathematics department.

All respondents claimed to have found the workshops useful. They all noted that working with other teachers was a major positive feature of the workshops. They felt that this exposure to the ideas of other teachers was very beneficial. They also commented positively on the fact that they were exposed to new teaching skills through this contract. Particular mention was also made of the fact that the workshops covered areas new to the syllabus, in which the teachers had not been trained previously. They felt that the workshops kept them up to date. Respondents were also pleased that troublesome areas of the syllabus received attention during the workshops.

All the respondents felt that the sections of the mathematics syllabus covered during the workshops were useful and appropriate. Calculus and sequences and series received particular mention.

All respondents expressed the feeling that their expectations of the workshops had largely been met, but one respondent noted the difference between the situation in the workshop and that which he faced in his classroom. He made particular mention of the environmental factors that had an adverse effect upon the pupils. Only one of the respondents felt that the environment within which he worked did not limit his ability to implement in the classroom what he had learnt from attending the Centre's mathematics workshops.

Problems mentioned by the others included a shortage of books, very large class numbers, and a lack of motivation on the part of the pupils. One respondent also noted that he worked in a rural school that had very limited facilities and none for duplicating materials.

The materials provided by the Centre during the workshop were deemed adequate, although a perception that more could be done about the provision of follow-up materials was voiced. All respondents expressed great confidence in their abilities since attending the workshops. Respondents were not confident that their attendance at workshops had any dramatically discernible impact upon the results achieved by their students, but they did feel that their pupils generally became more enthusiastic about their work. The respondents put this down to new methods of instruction that they had learnt and an emphasis on dealing with more practical examples.

The respondents felt that their principals supported their attendance of the workshops. One mentioned that the principal of her school reminded her to attend the workshops, and asked for feedback upon her return.

The respondents all claimed to pass on some of what they learnt at the INSET workshop to other teachers. This tended to happen informally. Two respondents mentioned that they were expected to pass on any materials that they had obtained from the workshops.

Only one of the respondents had attended an INSET programme other than the Shell one. This had been at the Umlazi Inservice Training Centre in January 1989. She felt that it did not compare with the Shell workshops as too much time was

expended upon one small part of the syllabus. This she attributed to poor planning.

Respondents noted that only teachers of standard 9 and 10 mathematics were invited to the Shell INSET workshops. Two noted that their principals had received letters inviting teachers to attend the workshops. Two respondents felt that the workshops should be open to all standard 9 and 10 mathematics teachers, while one felt that the invitation should be sent to the schools and the decision about attendance left to them.

One respondent professed to know nothing of the workings of the mathematics action committee. Two saw the committee as having responsibility for arranging the visits of external resource people to contribute to the workshops for selecting topics to be covered during the workshops, and for the provision of materials used in workshops. One respondent mentioned that the action committee also visited schools to help teachers with particular problem areas. It appeared that the respondents did not feel very strongly about the action committee, and none was willing to make any suggestions concerning the committee.

Two of the respondents had relatives working in a different education department to them. All liked the ideas of more contact between teachers of different departments because they felt they would gain more insight into problem areas through working with others. All respondents felt that contact with teachers of other education departments could best be achieved through common workshops. The agenda for these workshops should not be too rigid or formal, but with their work should be discussed. One respondent felt that a joint programme could be worked out for a series of workshops for the year. All respondents felt that the Shell mathematics INSET workshops should continue. Suggestions for change included holding more frequent workshops, arranging visits to the schools, and providing assistance with teaching aids, and convincing reluctant principals to support their teachers' attendance at the INSET workshops. Although all their principals were supportive of their attendance, they did know of others who were not.

Recommendations

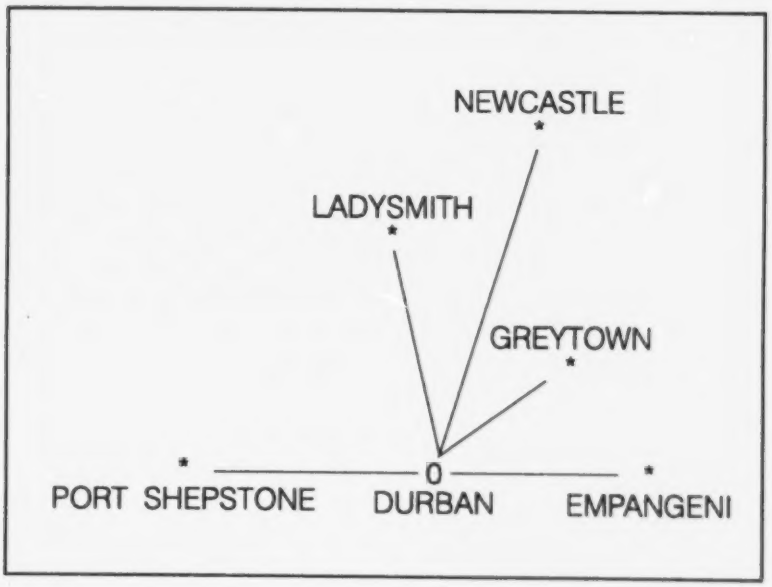
Based on the comments of interviewees one can make a number of recommendations. The teachers would benefit from participating in some mathematics workshops that more closely reflect the environment within which they work, which is characterised by a lack of high-technology teaching aids, uncongeniality, and severe overcrowding of classes. These problems should be directly addressed in a practical way by the Centre and teachers assisted in finding methods of coping with them. The broader environmental factors (political and other) affecting their work are not really amenable to intervention from the Centre.

The potential value of the broader dissemination of knowledge gained by participating teachers is not being fully realised. While they did not report passing on some information to other teachers, this appeared to happen informally and erratically. Principals or heads of departments should be encouraged to require that teachers hold feedback workshops to allow other teachers to benefit from their experience.

A discussion of the role of the action committee and the teachers' relation to it should help to clarify issues and broaden participation among mathematics teachers.

FIELD UNITS

The following two articles are representative of the activities of the Centre in promoting a decentralised, locally 'owned' network of resource centres in the Natal / KwaZulu region.



The Shell Science And Mathematics Resource Centre Network

S. Hardman

Introduction

This article describes the network of the Shell Science Centre, how it came about, how it operates, whom it serves, and the rationale behind the concept. This will be followed by an outline of the normative expectations of the operation, problems which are in evidence, and recommendations for the future development of the project.

What is the Science Centre Network

Reference is made in both the 1987 and 1988 evaluation reports to the decentralisation policy of the Centre. Botha (1987) indicates that four regional centres were established with a view to making the Centre's educational services available to as large an area as the financial constraints of the Trust would allow. The siting of the centres allows both urban and rural communities to be reached. Added to this, Botha envisages them as making the Centre's activities better known, enlisting support, and recruiting resources.

The four centres were established at KwaMbonambi, Newcastle, Ladysmith and Greytown. During 1989 a fifth centre was established at Port Shepstone. These bases span the whole area currently referred to as KwaNatal, that is the province of Natal and the self governing territory of KwaZulu. The patchwork nature of superimposing two political structures on one geographical region creates the situation that each of the units services schools in both political entities.

When reference is made to the network, confusion often arises as to whether the structure is being referred to or the teachers who participate in the activities of the various units, as they are referred to within the project. This confusion can best be avoided if one understands that both perceptions are valid, but that the aim of the Centre is to operate as a change agent in education. The physical structure has been created to provide bases from which groups of teachers can operate in utilising the resources made available through the Shell Science and Mathematics Resource Centre Trust.

The unit bases consist of rented offices equipped with basic office requirements, and are staffed by unit administrators and administrative assistants. The offices serve as a venue for meetings, and as administrative centres and mini resource centres. Resources available include video players and a selection of videos of relevance to the subjects offered, books and models, and science laboratory kits. Job descriptions of the staff of the network offices are contained in a document entitled The Field Unit Management Guide and disseminated by the Centre. The unit administrator is expected to ensure that all the business transactions of the unit are carried out in accordance with the regulations of the Trust. The responsibilities of the administrative assistant include taking minutes and typing (minutes, correspondence, and materials required) for INSET courses arranged by the local action committees. These members of staff, financed by the Trust, are intended to be supportive of local initiatives and report to teacher groups.

At each of these regional bases or units, through interaction with the local teaching body, various committees have been established. These committees, referred to as action committees, are elected by their peers (local teachers of senior secondary classes). Their main task is to meet together and decide upon the programmes they wish to organise and run in the interests of the teachers who elected them. This will include the drawing up of a programme of activities to submit to the Centre in Durban for consideration. Once programmes have been registered in Durban it becomes the responsibility of the action committees to implement them. Action committees are expected to report back to the Centre through minutes of meetings, attendance registers, and evaluation reports.

The Unit Management Guide clarifies procedures for these action committees to follow and emphasises the policies of the Centre. Essential characteristics of Centre policy are discussed with the management committee of each unit. This task is usually carried out by the liaison manager whose task it is to facilitate the operation of the unit. The management committee is constituted out of all the subject action committees operation from the unit.

The network therefore is made up of teachers serving in particular subject disciplines throughout the region who are supported in their efforts at managing INSET at the various unit bases set up the Shell Science Centre.

How did the network come about

Initially programme activities were centred in the greater Durban area with Michaelhouse as a venue where teachers from outlying districts could be accommodated for residential holiday courses. Hearing about these courses led to teachers from the whole region attending. Many teachers requested the Centre to provide them with a service nearer the schools in which they worked. This request fitted in with the developing rationale of the Centre and with the availability of funds, the concept was realised.

How does a unit operate

The Unit is managed by a management committee. This management committee is made up of the chairpersons of the various action committees that have been elected in the area. The committees comprise those of physical science, biology, English, mathematics, educational management, and community involvement. The rationale and programmes of these various committees are covered in other articles, some of which are included in this publication. An insight into one aspect of the dynamics of these committees is reported in the article: "Using evaluation data to plan actions".

The management committee meets on a regular basis to coordinate activities and assist the various action committee chairpersons with any problems which may arise, such as choosing suitable venues and how to approach principals who refuse to allow their teachers to participate in the programmes. The management committee also oversees the financial affairs of the unit.

Action committees plan and carry out activities in which local teachers participate. This planning takes cognisance of the arrangements of the various departments of education in terms of which teachers are allowed certain days off from normal school duties to attend in-service activities.

Who is served by the units?

Each local unit is intended to serve all the teachers in the area. This includes teachers from five different departments of education (Departments of Education and Culture for KwaZulu and for the Houses of Assembly, Representatives, and Delegates, and the Department of Education and Training). These departments covering similar geographic areas are divided according to race in the case of the various Houses, and according to their locality (Natal or KwaZulu) in the case of the DET and the KwaZulu Departments of Education and Culture. The two last mentioned departments are each divided into 25 circuits. The area covered by each of the units will depend on the availability of transport and the ability to build up communication structures to keep the teachers informed of events and enable them to participate.

Exhibit 1 is a map of the schools served by the Greytown unit. In this instance they are schools in the Maphumulo and Msinga circuits of the KwaZulu department as well as schools in the Umvoti circuit of the DET. Many of these schools do not have electricity, virtually all of them are overcrowded, and access to them is in most cases by dirt roads. The distances indicated on the map indicate the number of kilometers that teachers from the respective schools need to travel to reach the unit. It must be borne in mind that all of the schools mentioned are schools with senior secondary classes. In this same area there are three schools not included on the map serving the white community and two serving the Indian community.

The rationale of the network operation

At the outset is must be clearly stated that it is not, and never was, the intention of the Centre to establish structures in competition with the established systems of education. Rather, the intention was to implement a plan of constructive intervention which could be critically assessed and adapted by the various stakeholders in education. It is in this context that the following three points of rationale need to be placed.

Firstly, the Shell Science and Mathematics Resource Centre Educational Trust was established with the aim of developing a body of knowledge bearing on the content and practices of science and mathematics education. The purpose of the establishment of the network was primarily to involve educators in the programme of the Centre, so that they could benefit from the resources available at the Centre and from the knowledge accumulated by the Centre. The network must therefore be seen in terms of its function - namely establishing communication with clients and partners in education.

Secondly, from a systems point of view the Centre does not accept the present compartmentalised apartheid education system as absolute.

This means that although the Centre works with teachers contracted to various departments, the activities of the Centre are open to educators from all departments. The emphasis is placed on professional bonds which extend across departmental boundaries.

Thirdly, the model employed is one of the teachers' democratic participation in their own professional development. This means that through the activities of the Centre educators are encouraged to keep abreast of the continually growing body of knowledge which is of relevance to them. It is anticipated that through active participation with peers the educators might learn to analyse flaws in their own performance and think of ways to correct them. Innovation is encouraged while at the same time an ability to motivate innovation is expected. It becomes possible to communicate at peer level and critically adapt the ideas of others.

The normative expectations of the operation

There will always be a gap between the hopes and expectations of programme designers and the reality found to exist once the programme is implemented. However, it is necessary to indicate the chief expectations of the programme.

Firstly, by decentralising the operation more educators can become involved in the programme of the Centre. This refers to not only accessibility but also participation in the processes of planning, evaluating, and critical reflection essential in programme development.

Secondly, it is hoped that teachers from different departments would welcome the opportunity to meet colleagues serving in different departments and participating in professional development.

Thirdly, it is intended that through the professional development opportunities afforded by the programme the competence of teachers' will increase and this will lead to an improvement in school results.

Fourthly, it is hoped that teachers will be stimulated, through involvement, to improve their formal qualifications.

Lastly, it is expected that the opportunities of leadership made available in action committees will be of direct benefit in creating local school leadership.

The Network and Its Future

The concept of a network of teachers with structure across the whole region remains an exciting one. The potential for professional development and the realisation of the goals of the programme remain as worthwhile ideals to be striven for. Signs of success are emerging. For example, in the first semester report to the Trustees (Ziervogel states that "The Centre provided the background organisation for the Convention (mini convention of local biology and physical science teachers). Approximately 49 biology teachers attended, many of whom were teachers from the networks. Two of "our" teachers gave talks and ran workshops").

However, it remains crucial for the dynamics of group participation to be balanced with responsible leadership development so that the advance made by the programme can become part of an ongoing growth process in improving education.

Using Evaluation Data for Planning Actions: A Learning Experience for Developing Decision-making Skills

S Hardman

Introduction

The action committees are expected to make decisions about the programmes of the Centre. Since most action committee members have not received any systematic training in decision making, an attempt was made to involve them in an exercise aimed at improving their decision-making skills by creating an awareness of the informational potential of evaluation data. This article presents a brief description of the work of the action committees in the Shell Science Centre Network Project and then examines their function. This is followed by reports of the Centre's attempt to increase awareness of the importance of evaluation data in enhancing decising-making skills and of the implications of this exercise the recommendations for future developments in this field.

The context of the learning exercise

Early in 1990 the six subject action committees at each of the five regional units operating outside the Durban area were requested to plan their activities for the year. To facilitate the transmission of the plans to the Centre, a summary form enabling all relevant information to be presented on one simple sheet was designed. This made the fax transmission of the plan a relatively simple operation and also the reproduction of the plan for all who needed the information. The action committees were requested to submit information on the participant group they were planning for, the objectives of the workshop, the workshop budget, the programme, the materials needed, the evaluation activities they intended to carry, the tutors taking part and the duties the tutors were expected to perform. A short guide providing details on how to collect the information was also supplied.

Many of the committees found it necessary to seek help from the Centre as planning for a complete year was a novel task for them. Not all thirty action committees managed to complete the required planning in time. Some committees found it difficult to find the time to meet deadlines for submitting a plan. However, by the end of March 1990, 116 programmes had been registered for the year. Of these, 13 were biology programmes, 19 English, 19 physical science, 23 mathematics, 27 community involvement, and 15 education management. It is against the background of the number of programmes involved that the need for monitoring and leadership development becomes clear.

The rationale for working through action committees

It is clear that much less planning would be necessary if the project had been carried out centrally. Programmes could have been coordinated and designed in such a way that the work was covered as broadly as possible, and experts in various subject areas called upon to lead sessions. The Centre decided, however, to introduce a decentralised system in which local educational communities did as much of the planning as possible. This model was justified by Hobden (1990) on the basis of the following assumptions of Orlick (1987):

- fundamental reform comes about only if teachers introduce it
- teachers are unlikely to change their teaching simply because they are told to do so
- teachers take reform seriously only when they define their problems themselves, determine their needs, and voluntarily seek help.

The policy of the Centre is therefore to make action committees possible, encourage them to take responsibility for planning and implementing INSET, and assist them as partners in the collaborative exercise of professional development. From the above it can be seen that decision-making at local level is a key to the implementation of successful INSET programmes.

The process of implementation and use of evaluation techniques was seen as one offering potential for skills development in decision-making. Not only is evaluation a process which the Centre has always maintained forms part of any activity which it supports, but also it is an aspect

of the programme open to the sharing of critical appraisals between the Centre staff and the action committees. The importance of evaluation as a tool for programme planning has been acknowledged both by the Centre coordinators and by the action committee members. This makes it a good agenda in the partnership relationship the Centre seeks to maintain between its personnel and clients.

An approach to improve decision-making
In order to develop skill for using evaluation data for decision-making, an exercise was planned which gave action committee members an opportunity for using evaluation data. Members of the action committees were requested to use questionnaires at the end of INSET programmes.

Separate forms were developed for the course leader (usually referred to as the tutor) and the participants of the course. Responses to these questionnaires were given to the action committee members. They were requested to submit the raw data to the staff member responsible for improving the decision-making data capabilities of the action committee. The data were processed at the Centre and feedback in the form of summaries was sent to the action committees.

The members of the action committees were requested to use this information in their administration of future courses. This procedure was designed to show the action committees the benefits to be derived from continual evaluation, and to encourage them to participate in the evaluation of their workshops.

The critical appraisal of evaluation results is seen by the Centre staff as essential to improving the decision-making procedures of the action committees.

The questionnaires

Two questionnaires were administered, one for course leaders and one for teachers who participated in the INSET session.

Questionnaire for Course Leaders
This questionnaire given to the course leader contained six questions dealing with the implementation of the programme plan, teaching methods, and their feelings about the programme and also other comments and recommendations.

Questionnaire for Teachers
The questionnaire administered to teachers elicited information of events at the INSET workshop, their attitude toward these, and suggestions for future procedure. These questions gave teachers an opportunity for reflecting on the activities, commenting on how they responded to the INSET workshop, and offering suggestions for future courses.

Responses to the questionnaire

Responses to the questionnaire arrived from all six units. A sample of nine sets of data was considered. All units except Ladysmith were represented. All subject areas were covered. In the case of one committee two different workshops were covered. The sampling was done on the basis of programmes conducted during the first semester and for which substantial data were available to the investigator.

Course Leaders' Responses
The responses summarised below follow the order of the questions appearing in the questionnaire. With regard to their plan for the day all course leaders indicated that the course went as planned although three of them mentioned that they had to cut down on the amount of work covered as a result of the late arrival of participants. All course leaders indicated that they were satisfied with teacher participation. It was emphasised that delegates participated actively.

All course leaders considered the courses successful. Criteria used included evidence of the teachers' enjoyment of the course and their participation in discussion. An interesting range of suggestions were made for follow-up. These included follow-up visits to schools' and further workshops on the same topics. One suggestion was the revision of past exam papers.

Significantly in all cases the school subject workshops concentrated on syllabus content.

Teachers Responses
Teachers liked the course leader to use participative methods allowing them to air their views and discuss the content. They enjoyed working in groups. They liked courses to concentrate on aspects of the syllabus.

Teachers did not like lectures to go on too long, too much work to be covered at one time, or work to be covered in the course that they had already covered at school. They were disappointed at not meeting some teachers at the course whom they had expected to be there. They were incommoded by the unpunctuality of arrangements caused by waiting for latecomers. Transport arrangements were found to be cumbersome, inconvenient, and costly. Many teachers felt that the course was too short and that not enough subject content was covered in INSET activities.

A vast range of suggestions were made for future courses, most of them very broad and rather vague.

Using evaluation summaries

It is not the intention of this article to evaluate the INSET activities. Rather, the focus is on the process of decision-making and its development as an integral part of successful INSET implementation. For this reason the findings presented above have to be considered in the light of how they can be used by the decision-makers - the action committees themselves. Therefore at this stage the summaries will be examined in terms of their potential benefit to the action committees.

The responses indicate that teachers who attend the courses have expectations concerning what should happen in the INSET workshop and how it should happen. If expectations are not sufficiently met, it is likely that teachers will lose interest in the project. Secondly, teachers' responses highlight the main features of an INSET programme from the point of view of teachers. These include starting and finishing time, teaching methods employed, accommodation and transport, subject content, and so on. Thirdly, by comparing the responses of the participants with those of the tutors, the importance of careful planning by both the action committee and tutor is evident. Thus both teacher and tutor parties see latecoming as a particular problem in the workshop.

All three of the above issues flow from an analysis of the information and are of direct relevance to the action committees for improving the INSET actively that they initiate.

Action taken in the wake of the experience

The utility of the evaluation information for planning has been discussed with members of action committees. From these discussions certain problems have come to light.

Firstly, the action committees have indicated that, although the information provided in the form of summaries of responses is useful, the time lapse between the programme and receipt of the summaries diminishes the value of the information. As a result, it has been decided that instead of the raw information being sent in to the Centre, the action committee should use it directly after the INSET session at a meeting of the action committee. This also alleviates the problem of committee members having to find extra time to hold meetings, especially as they come from different schools and have to travel considerable distances.

Secondly, the action committees reported that teachers were in a hurry to leave after sessions and that, as the questionnaires were filled in at the end, they did not receive the attention they deserved. Accordingly it has been recommended that more creative evaluation techniques be designed and implemented. Example suggestions include that some teachers should interview others using set questions, and that short reporrts be written up and handed in. Another is that teachers be given a few leading questions to discuss in a short group session. This would again end with a short report being handed in. It has also been recommended that information gathered activities be slotted in at different times in the programme. This should lead to participants not feeling so pressed for time at the end.

Conclusion

The exercise for developing decising-making skills as described in this article highlights the reality of implementing INSET based on the model advocated by the Shell Science Centre. The importance of using evaluation data as an input for decision-making has been acknowledged by all parties participating in the INSET activities. Nevertheless, flaws have been detected in the way evaluation information is collected and processed. To speed up the utilisation of data, action committee members should convene immediately after the adjournment of the INSET session to summarise the evaluation forms and discuss the implications of the findings there and then. Data collection procedures are to be improved and peer interviewing introduced and also small group discussions about the perceived utility of each course.

The progress being made in this exercise needs to be set in the context of a long-term operation in which teachers are able to meet at regular intervals, discuss matters of relevance to their teaching, cooperate in developing materials, and conduct a certain amount of class-based research and curriculum development.

Concluding remarks

A. Lewy

This volume contains a series of descriptive studies about activities conducted by the Shell Science and Mathematics Resource Centre during 1990. It contains reports about in-service training activities in three subjects, namely physical science, mathematics, and biology, and about some aspects of the community involvement project. The descriptive studies of the programmes are supplemented with observational and interview studies by external evaluators of the University of Natal, who were contracted by the Centre. The volume contains evaluation information from four sources: the self evaluative comments of the project coordinators; the views and experiences of the Centre's clientele, namely teachers participating in the INSET programme and young persons participating in the youth leadership programme; evaluation by experts contracted at local level; and the contribution of a visiting scholar, who observed the work of the Centre's staff, discussed substantial and methodological aspects of their self-evaluation procedures with them, reviewed the available written reports, and examined the soundness of the methods used and the validity of the evaluative inferences.

A further evaluative input occurred in the form of unobtrusive data (Webb et al. 1966), a term used to characterise data collected not at the request of an evaluator but as an invited by-product of the natural flow of office routine. Such data might accrue to a visitor sitting for a month at the Centre's main office and observing those working at their desks; talking informally to action committee members and other clients who visited the Centre informally; or answering telephone calls meant to reach one of the Centre's staff members.

Teachers from various schools telephoned the Centre for information about activities planned or advice about implementing in their schools ideas discussed in previous INSET sessions. They would ask about the availability of resource materials, booklets produced and distributed by the Centre, videos, and other types of equipment. The clientele view the Centre as a friendly institution whose staff may be approached without any formality or previous appointment, and they know that their questions or requests will receive serious attention.

The visitor will not fail to be impressed by those in charge of planning and implementing the programme on overhearing the informal interaction between staff members over current problems encountered in their work; having a glimpse of recent issues of local and international journals of education on the desks of coordinators and observing some section marked in yellow highlighter on pages of these journals; standing at a computer screen and looking at the work carried out by a staff member; reviewing the large stocks of educational videos on the shelves and seeing some excerpts from these on the screen; or surveying the book stock.

The support provided by the administrative and service staff for carrying out the educational work is also strongly felt by a visitor.

A sense of community is a precondition for the effective operation of an institution. The following list of norms and values are characteristic for such a sense of community; collaboration, colloquiality, cohesiveness, support, commitment, open communication, shared decision making, cooperation, ownership, and team spirit. Daily life in the Centre evidences a sincere effort on the part of the staff to internalise these values.

But having a strong sense of community does not mean that the operation of the Centre's programmes is without problems. Indeed in the reports on particular programmes some flaws are pointed out, which can be summarised as the discrepancy between the staff's ambitious goals and their realisation. In particular the discrepancy between the ambition of having decisions about educational programmes evolve from democratically operating action committees and the actual pattern of decision making is evident.

The management of in-service training programmes can be effective only if there is a better articulation about which decisions need expert judgement. A demand does not necessarily represent a need, and clients are not always aware of their real needs. Democratic decision making must be supported by meticulously planned needs assessment studies.

Another issue requiring further clarification is that of the professional development of teachers. The observational studies reported in this volume suggest that there is a discrepancy between teachers' perception of their in-service needs and coordinators' perception of the real needs. The Centre should initiate a series of discussions to

clarify what is understood by the professional development of teachers and develop a multi-phase project in which the operational goals of each phase are clearly operationalised. This implies not that the Centre's ambitions should be lowered, but that for the long-term attainment of these goals interim goals need to be set.

I shall conclude with some suggestions which may assist in strengthening the research and development component of the Centre as applied to the improvement of the education of disadvantaged groups in the country.

The INSET programmes run by the Shell Science Centre are built on principles derived from the findings of recent empirical and analytical studies of leading science educators. The coordinators of the programmes are familiar with trends in this field and being linked to international information bases, regularly obtain details of innovations in the field of INSET and science teaching long before they are reported in print. Their personal contact with leading experts in the field of their specialisation in South Africa and in other countries, and their active participation in international conferences and seminars help them to keep abreast of developments in the field. This is well noticed in the records of their work. They incorporate in INSET programmes ideas like the constructivist approach to learning, use concept mapping as a learning device, and create handouts to be used by the teachers which reflect the ideas mentioned above. Their work is characterised by an openness to change, and the visitor reviewing the work of the Centre in 1990 may observe activities and methods of teaching not present a year ago.

Nevertheless the approach of the coordinators is arguably too single-minded. During the time they absorb innovations and may change their mode of operation, the change occurs across the board and is introduced in all INSET activities in a particular subject of the Centre.

There is a lack of "planned variation" in the work of the subject coordinators. Planned variation would require the introduction of changes in the mode of operation across sites or across INSET situations. The changes may be minor differences in organisation setting, mode of presentation, or pattern of follow-up, which would enable to compare the relative effectiveness of various courses of action and base policy decisions on empirical findings.

The repertoire of possible variations is unlimited. Some possibilities are mentioned here.

- The Centre operates a project described in this volume as the Laboratory Development Project. One variation may be to create links between INSET activities provided for teachers in a particular school and the Laboratory Development Project and to assess the impact of such a combined treatment in the particular school.
- Several fostering programmes abroad have combined group in-service education activities with individual guidance to science teachers. While financial considerations may prohibit to broaden the scope of the Centre's services, it may be appropriate to add such a component for a small group of teachers. The attendance records show a high level of perseverance among some teachers, who continued to participate in the INSET activities of the Centre for a period of 6 years. It may be of interest to offer guidance to some of these teachers in carrying out their work in the classroom and to examine the combined effect of INSET and personal guidance.
- Recent trends in increasing the effectiveness of teaching emphasise the importance of viewing the school as a system and accordingly dealing with individual teachers as members of the school community rather than responding to their personal needs only. For this reason, it may be of interest to fit the INSET education provided to particular teachers into the broader framework of their schools. A convenient way of doing this may be to identify a school contributing several teachers to the Centre's programmes (in mathematics, science, management, etc.) and to add to separate subject-related INSET programmes a common programme component for all these teachers, or for the teachers of a particular department in the school, in which senior administrative members may also participate.
- Another variation may be to create links with the community and work together with it in improving science education in a particular school.

The project coordinators may prefer to experiment with variations of other types. Experimentation with variations has several advantages. It keeps the team which is in charge of providing services on their toes, it provides a basis for making decisions about future action, and it sets an agenda for discussion at staff meetings. Researchers favour to include planned variation into programme managed by them because it allows the production of knowledge which may have implications for future planning.

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